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May 15, 1990

Energy Research Abstracts

Abstracts 21117–23257

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

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ERA is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate for 24 semimonthly issues is $184.00 for domestic subscribers and $230.00 for foreign subscribers. A single issue costs $27.00, domestic, or $33.75, foreign. Cumulative indexes are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

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In the exercise of its rights and responsibilities under the agreements to which it is a party, the **Office of Scientific and Technical Information** both receives information from the above sources and submits U.S.-produced information to them. In addition to materials generated by the Department of Energy, this U.S.-produced information is gathered from other government agencies as well as under contract with private information processing companies. All input is computer processed and entered into a database for online retrieval. The database serves as well for the production of numerous OSTI publications.

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1. **Abstract number** within volume.
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3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
11. **Number of pages** or page range.
12. **Language** of document if non-English.
13. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
14. **Publisher's name and location** for documents published by a corporate or commercial source.
15. **Sponsoring organization.**
16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020--: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Journal articles *Chemical Abstracts Service Source Index (CASSI)* tells which libraries, both U.S. and foreign, contain a journal and the available years. *Ulrich's International Periodicals Directory* contains information on the journal and its publisher. For librarians, another source of information is On-Line Computer Library Center (OCLC), for interlibrary loans.

Books, conferences, and monographs The source for these publications is the publisher or the originating society, organization, or institution. DOE-supported conferences and individual papers reporting DOE-supported research may be available as reports from OSTI.

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National Translation Center
Washington, D.C. 20540
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United Kingdom

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
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TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
15:17641 DOE/ER/60664–1

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

0103 Preparation

Refer also to citation(s) 21147

21117 (ORNL/TM–11386) **Chemistry and structure of coals: Effects of grinding media on a subbituminous coal.** Fuller, E.L. Jr. Oak Ridge National Lab., TN (USA). Jan 1990. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90008021. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Coal preparation techniques used to provide feedstocks for direct utilization in combustion facilities require extensive grinding. Separation of noxious elements (mineral matter, sulfur, nitrogen, etc.) is facilitated by grinding. Current and future needs for clean air require that more complete separation be carried out. Chemical cleaning processes can be combined and carried out simultaneously by incorporation of chemicals in the grinding media. This work has shown that the argillic mineral matter hydrolyzes in aqueous grinding media and the hydrolysis is markedly enhanced in alkaline media. Direct incorporation of carbon dioxide is accomplished in the alkaline media to form ketone and acid salt groups on the surface of subbituminous coal particles. Diffuse reflectance infrared spectroscopy has been shown to be an excellent aid in defining the chemical and physical changes induced in the grinding process. 8 refs., 12 figs.

0104 Processing

Refer also to citation(s) 21163, 21303, 22094

21118 (AIST–8902-1) **Japan's Sunshine Project. 1988 Annual summary of coal liquefaction and gasification.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 357p. (In Japanese). Order Number DE90753037. Available from NTIS (US Sales Only), PC A16/MF A01.

An outline of 1988 annual summary of coal liquefaction and gasification was described. On the development of bituminous coal liquefaction, the overall operation of a NEDOL process 1 ton/d process support unit (PSU) was completed. A 150 ton/d pilot plant (Wandoan coal basis) was designed using the data of the improvement of liquid products distribution, pretreating conditions, liquefaction conditions and catalysts, which were obtained through experimental works. For FY 1991, this R and D project shall enter into construction stage. The development of the liquefaction process for the brown coal of Victoria had agreed between Japan and Australia in 1980. A 50 ton/d pilot plant, which is the brown coal 2-step hydrogenation liquefaction process, had started the full-scale coal-in operation in 1988. Liquefied oil yield of more than 50 % is expected to be attained, and de-ashing performance below 1000 ppm and catalyst activity with long-run operation are demonstrated. Meanwhile, utilization and upgrading technologies of coal derived products were investigated. The construction of a pilot plant for coal based hydrogen production adopted by the entrained flow gasifier, was started, and is planned to be completed in 1990. A 200 ton/d entrained flow coal gasification combined cycle power generation pilot plant is planned to be constructed in 1990, it is provided necessary data from the existing Yubari 40 ton/d test plant. 157 figs., 89 tabs.

21119 (AIST–8902-2) **Japan's Sunshine Project. 1988 Annual summary of coal liquefaction and gasification.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 298p. Order Number DE90753038. Available from NTIS (US Sales Only), PC A13/MF A01.

An outline of 1988 annual summary of coal liquefaction and gasification was described. On the development of bituminous coal liquefaction, the overall operation of a NEDOL process 1 ton/d process support unit (PSU) was completed. A 150 ton/d pilot plant (Wandoan coal basis) was designed using the data of the improvement of liquid products distribution, pretreating conditions, liquefaction conditions and catalysts, which were obtained through experimental works. For FY 1991, this R and D project shall enter into construction stage. The development of the liquefaction process for the brown coal of Victoria had agreed between Japan and Australia in 1980. A 50 ton/d pilot plant, which is the brown coal 2-step hydrogenation liquefaction process, had started the full-scale coal-in operation in 1988. Liquefied oil yield of more than 50 % is expected to be attained, and de-ashing performance below 1000 ppm and catalyst activity with long-run operation are demonstrated. Meanwhile, utilization and upgrading technologies of coal derived products were investigated. The construction of a pilot plant for coal based hydrogen production adopted by the entrained flow gasifier, was started, and is planned to be completed in 1990. A 200 ton/d entrained flow coal gasification combined cycle power generation pilot plant is planned to be constructed in 1990, it is provided necessary data from the existing Yubari 40 ton/d test plant. 136 figs., 82 tabs.

21120 (CONF-900562–2) **Corrosion properties of Fe_3Al in H_2S-H_2-H_2O mixtures.** DeVan, J.H. Oak Ridge National Lab., TN (USA). [1989]. 2p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Meeting of the Electrochemical Society; Montreal (Canada); 6-11 May 1990. Order Number DE90004936. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Compatibility with mixed gases containing sulfur, oxygen, and chlorine is a critical requirement for high-temperature alloys used in coal conversion applications. The studies had two primary objectives: (1) to evaluate the effects of low concentrators (1–2%) of elemental additions, such as Nb, Y, and Zr, on the sulfidation resistance of Fe_3Al, and (2) to establish the cause of the detrimental effect of Cr on the sulfidation resistance of these alloys at concentrations above 2%. All experiments were conducted in flowing H_2S-H_2-H_2O mixtures with relatively low oxygen activities and high sulfur activities. Alloys were exposed at 700 and 800°C in isothermal tests and between 25 and 800°C in thermal transient tests. The resultant weight changes during microbalance exposures of 120-300 h were analyzed to establish reaction kinetics for scale growth and exfoliation. The scales and underlying alloy were also analyzed to relate oxidation and sulfidation processes to alloy content. 1 ref.

21121 (CRIE-W–88036) **Behavior of NH_3 in coal derived gas (Part 1). Continuous ammonia analyzer for coal derived gas.** Matsuda, Hiromitsu; Nakayama, Toshio; Tanaka, Takashi; Kobayashi, Makoto; Akiyoshi, Hisashi. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1989. 36p. (In Japanese). Order Number DE90753099. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to establish a continuous monitoring technique of NH_3 in coal derived gas, conventional continuous NH_3 monitors for flue gas were surveyed and evaluated the applicability to coal derived gas. Then the system of continuous NH_3 analyzer for coal derived gas was established and continuous measurement of NH_3 was conducted. Ultraviolet absorption method is excellent in terms of a direct method and simple sampling system and is applicable to coal derived gas with relatively high concentration of NH_3 by using absorption at 2215 angstrom. Continuous NH_3 analyzer using ultraviolet absorption has excellent performance as an automatic analyzer, which is satisfied JIS standard, and is hardly affected by the coexist gases, such as H_2S, CO, CO_2 and H_2. Continuous NH_3 measurement with cumulative measuring time of about 60h was performed using three kinds of coal in a 2 ton/d coal gasifier plant, the measured values agreed with the results by chemical

analysis in the NH_3 concentration range of 200 to 1800 ppm. 1 ref., 18 figs., 6 tabs.

21122 (DOE/MC/23291–2780) **Novel electrochemical process for coal conversion: Final report.** Farooque, M. Energy Research Corp., Danbury, CT (USA). Jul 1989. 55p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-87MC23291. Order Number DE90000432. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The feasibility of two distinctly different routes to coal conversion at low severity conditions was investigated. An electrochemical approach utilizing both the electro-oxidation and electro-reduction routes was employed. The electro-oxidation route consists of an electrochemical reaction involving H_2O and coal, leading to the breakup of coal molecules. The observed reaction rate has been explained as a combination of the coal and pyrite electro-oxidation currents. Organic sulfur has been identified as the contributing factor for the observation of more than 100% H_2 production current efficiency with several coal samples. Also, an attractive coal pretreatment process has been identified which results in production of useful products and simultaneous upgrading of the coal. Electrochemical oxidation of coal with H_2O leads to the production of hydrogen, CO_2, simultaneous removal of pyritic sulfur, and significant reduction of ash content. There is also indirect evidence that the organic sulfur may be removed in the process. A preliminary economic evaluation of this process has projected a cost advantage of > $8 per ton of Illinois #2 coal. A lab-scale cell has been successfully employed in this study for generating process data useful for future design calculations. This study also explored the electro-reduction route of coal conversion and has successfully demonstrated production of liquid products from different coal types at low severity conditions. A variety of aliphatic and aromatic compounds have been identified in the products. Coal type appeared to be the most important parameter affecting the product spectrum. 32 refs., 26 figs., 19 tabs.

21123 (DOE/METC–89/6107-Vol.1) **Proceedings of the ninth annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.** Johnson, R.A.; Dorchak, T.P. (eds.). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1989. 358p. Sponsored by U.S. DOE Fossil Energy. (CONF-890666–Vol.1: 9. annual gasification and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 27-29 Jun 1989). Order Number DE89011706. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

Research programs from the contractors review meeting on gasification and gas stream cleanup systems are presented. Major topics include: systems for the production of power and gas stream cleanup; production of synthesis gas; and production of co-products. Research discussed during poster sessions are also included. Individual projects are processed separately on the data bases. (CBS)

21124 (DOE/METC–89/6107-Vol.2) **Proceedings of the ninth annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.** Johnson, R.A.; Dorchak, T.P. (eds.). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1989. 315p. Sponsored by U.S. DOE Fossil Energy. (CONF-890666–Vol.2: 9. annual gasification and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 27-29 Jun 1989). Order Number DE89011707. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

Research programs, presented at the contractors review meeting on gasification and gas stream cleanup systems, are presented. Major topics included the following: systems for the production of power, systems for gas stream cleanup, production of synthesis gas, and production of co-products. Poster session topics are included. A total of sixty-six topics (including poster session topics) were addressed. Individual projects are processed separately on the data bases. (CBS)

21125 (DOE/PC/88919–T3) **Bioprocessing of lignite coals using reductive microorganisms: Progress report No. 3, August 15, 1989–January 31, 1990.** Crawford, D.L. Idaho Univ., Moscow, ID (USA). Dept. of Bacteriology and Biochemistry. [1990]. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88919. Order Number DE90007228. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Depolymerization of lignite is being investigated. Research objectives include: isolate and characterize microbial strains that carry out chemical transformations of lignite coal that would cause its depolymerization, reduction, and/or liquefaction; characterize desirable reactions by growing selected of the microbial isolates on coal model compounds, and determine if the reactions occur when the microbial strains are growing on coal; and characterize several newly isolated coal-depolymerizing bacteria to determine their mechanisms of coal depolymerization, and utilize the depolymerized coal as a substrate for the isolation of additional strictly anaerobic bacteria that reductively transform the depolymerized coal. Since the last report we have made a significant breakthrough in our characterizations of the coal depolymerization mechanism. Not only have we characterized several additional bacterial strains that are superior to P. cepacia DLC-07 in their coal depolymerization abilities, but we have confirmed that depolymerization is catalyzed by a highly active extracellular enzymatic activity in several Pseudomonas and Flavobacterium strains. Our breakthrough discovery of a coal-depolymerizing enzyme system opens the way for elucidating the mechanism by which bacteria attack the macromolecular structure of lignite coals. 8 figs., 1 tab.

21126 (DOE/PC/89877–1) **Catalyst dispersion and activity under conditions of temperature-staged liquefaction: Technical progress report, October–December 1989.** Davis, A.; Schobert, H.H.; Mitchell, G.D.; Artok, L. Pennsylvania State Univ., University Park, PA (USA). Jan 1990. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89877. Order Number DE90008280. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Objectives of this research are to investigate the use of highly dispersed catalysts for the pretreatment of coal by mild hydrogenation, identification of the active forms of the catalysts and classification of the mechanisms of catalysis. The ultimate objective is to ascertain if mild catalytic hydrogenation resulting in very limited or no coal solubilization is an advantageous pretreatment for the transformation of coal into transportable fuels. The program will focus upon the development of effective methods of impregnating coal with catalysts, evaluating the conditions under which the catalysts are most active and establishing the relative impact of improved impregnation on conversion and product distributions obtained from coal hydrogenation. Some of the transformation and solubility characteristics of two catalysts have been investigated. The poor solubility of three separate lots of commercial ammonium tetrathiomolybdate (ATM) in water, THF and pyridine and their behavior during thermogravimetric analysis, suggested that quality control on synthesis of this material had been very poor. Because of this variability, we believe it may be more advantageous to prepare a sulfided ammonium molybdate catalyst in-house by reacting aqueous ammonium heptamolybdate with hydrogen sulfide. Thermogravimetric analysis and microautoclave experiments performed using ferrous sulfate in a nitrogen atmosphere demonstrated that decomposition to anhydrous ferrous sulfate occurs below 265°C and conversion to ferric oxide above 575°C. 6 refs., 3 figs.

21127 (DOE/PC/90528–T7) **Thermodynamics of coal liquid/solid systems: Final report.** Holder, G.D.; Lee, Chang-Ha. Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering. Aug 1989. 77p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90528. Order Number DE90004178. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Thermodynamic data for many organic systems have been developed for the petroleum industry. This data, however, is limited to the paraffinic compounds while the liquids produced in coal liquefaction are highly aromatic and may contain heteroatoms such as sulfur, oxygen and nitrogen. An effort to generate data bases for these aromatic compounds has been recently made. One of the goals of this work is to expand the data bases so that the properties of coal liquefaction products are accurately determined. This effort has three basic components: pure component physical properties; binary vapor pressure data which enables phase behavior to be calculated for binary and, assuming the interaction of unlike

molecules are independent of the presence of a third species, multicomponent systems; and vapor pressures of solid-liquid systems as a function of the solids content. This allows the effect that solids have on the distribution of liquids between phases to be calculated. 20 refs., 3 figs., 55 tabs.

21128 (FSC–8903, pp. 9-13) **Method for estimating maximum exposured temperature of coke by laser Raman spectometry.** Suzuki, Yoshio (NKK Corp., Tokyo, (Japan)); Itagaki, Shozo; Mitani, Shigeyasu; Chino, Atsushi. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

In order to clarify the coke breeze generation, transferring and depositing behaviors in a blast furnace, the method to estimate the maximum exposured temperature was developed by using laser Raman spectroscopy equipped with a multi-channel detector which can rapidly measure the maximum exposured temperature of many breezes to study the coke behaviors in the blast furnace. Three kinds of coal of different coal ranks were carbonized and the effect of coal kinds and structural components of coke on the degree of graphitization and the distribution of graphitization degree of heat treated coke surfaces and cross sections were investigated to determine the sample preparaing conditions optimal to estimate the maximum exposured temperature of coke taken from the blast furnace. Then, surfaces of sample breezes were macroscopically measured to determine the formula estimating the maximum exposured temperature, and the effect of heat treating time and alkali on the degree of graphitization was studied by supposing coke behaviors in the blast furnace. The maximum exposured temperature on coke taken from the blast furnace during the stopped blasting to apply this method. In near future, coke in the blast furnace during blasting is to be taken and investigated. 2 refs., 8 figs.

21129 (FSC–8903, pp. 24-27) **Study on homogenizing methods of bulk density in coke oven.** Kato, Shunji (Sumitomo Metal Industries, Ltd., Osaka, (Japan)); Yoda, Kiyoshi; Nishioka, Kunihiko; Inoue, Keizo; Takahashi, Hiromichi. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

The homogenization of bulk densities in coke ovens was examined by using simple levelers. A prototype distribution leveler with distribution plates was provided to homogenize longitudinal bulk densities, and a loading leveler equipped with a loading plate on the distribution leveler to homogenize vertical bulk densities. Those levelers were tested inserting them into a full-scale steel model oven. Holding stationary or reciprocating the distribution leveler, the change of bulk densities was examined under different coal charging conditions, and as a result, the effect of the leveler was highly dependent on distribution plate angles and coal distribution rates, with the maximum effectiveness at 20 degrees in angle and 70mm in top open width of the plate. After estimating an effective load by a small scale charging test and simulation, the loading leveler was tested, and as a result, highly effective homogenization was verified in the depth range to 1.5m under a bulk surface. 4 refs., 10 figs., 1 tab.

21130 (FSC–8903, pp. 28-32) **Development of automatic control system of CDQ operation.** Tahara, Toshihide (Nippon Steel Chemical Co., Ltd., Tokyo, (Japan)); Sasayama, Motohiro; Hoshihara, Hiroshi. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

The outline and results were reported of an integrated automatic control system for three coke dry quenching (CDQ) plants. The existing computer of an automatic combustion control (ACC) system for coke ovens was utilized as a hardware. The air control subsystem for combustible gas was dveloped to enhance a steam yield, and the automatic control was consequently achieved by which the total steam yield of three CDQs could be maximized within the acceptable steam quantity of a turbine considering the change in coke charging pitch, prechamber level and coke pushing rate. The coke pushing control subsystem developed for labor saving attained the automatic control of coke pushing based on a coke charging schedule and chamber level information, and the change in coke pushing rate was consequently reduced together with the labor saving. The operation analysis subsystem utilizing various online data was also developed. 7 figs., 3 tabs.

21131 (FSC–8903, pp. 33-37) **Construction and operation of coke dry quenching plant for Oita No. 1,2 coke ovens.** Ito, Shigeo (Nippon Steel Corp., Tokyo, (Japan)); Komatsu, Toshiyuki; Onishi, Teruaki; Sanada, Teruo. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

The outline and operation results were reported of the 190T/Hr super large coke dry quenching (CDQ) plant for No. 1 and 2 coke oven of the Oita Steel Plant, Nippon Steel Corp. An angular steel pile work was chosen as a foundation work because of weak ground, and concrete-filled steel pipes were adopted for plant posts. The CDQ plant composed of one chamber and one crane for two coke ovens was constructed diagonaly at 35 degrees to the coke ovens because of a restricted site. An electrical and instrumental control were integrated into one control system, and the CRT console was adopted capable of displaying an operation, adjusting and failure information on the same screen. As the results of demonstration tests, since the temperature of pushing coke was lower than a designed one while keeping a designed steam yield, the cooling capacity exceeded a specified value. The introduction of the CDQ resulted in an extremely large energy saving effect of 650 x 10^{12}cal and the enhancement of a coke quality. 6 figs., 3 tabs.

21132 (FSC–8903-86) **86th coke special lecture. Proceedings (1986).** Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. 41p. (In Japanese). Order Number DE90752836. Available from NTIS (US Sales Only), PC A03/MF A01.

This papers is the preceedings of the 86th coke special lecture held by coke comittee, Fuel Society of Japan, on April, 1989. The announced lectures were seven researchs and two special lectures by the guests. The outline of the lectures are as follows: Four researchs were presented about the physical properties of coke such as, influence of coal properties on pore structure of coke, effect of bulk density of charged coal on the distribution of CSR across the oven width, method of estimating maximum exposed temperature of coke by laser Raman spectrometry, charactrization of various coals by Ft-IR ^{13}CP/MAS FT-NMR and Raman spectrometry, three researchs were presented about the coke oven operation such as, a study on homogenizing methods of bulk density in coke oven, development of automatic control system of CDQ operation, construction and operation of coke dry quenching plant for Oita No 1,2 coke ovens, and the subject of special lecture were, technical trend of recent monothilic refactory, on the international environmental problems. 18 refs., 58 figs., 9 tabs.

21133 (K/QT–352) **Development of ceramic membranes for gas separation: FY 1989 development activities.** Fain, D.E.; Kidd, G.J. Jr.; Roettger, G.E.; White, D.E. Oak Ridge Gaseous Diffusion Plant, TN (USA). Feb 1990. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OT21400. Order Number DE90008737. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of the current project is to use the technology base available at ORGDP to develop membranes that will be of significant economic value to the nation for the economical use of fossil energy materials. The first part of the project will be directed toward fabricating a membrane to separate hydrogen from the synthetic gas produced by coal gasification processes. Later efforts will be directed toward tailoring membranes to eliminate the acid gases, such as sulfur and nitrogen oxides and hydrogen sulfide, from gasified coal. Project activities during FY 1989 focused primarily on developing small pore size ceramic membranes and developing a model for transport of various gases of interest through such membranes. As membranes having smaller pore size were produced and tested the need to improve the resolution of some of the test systems was recognized and such improvements

were implemented. This report summarizes project activities during FY 1989 related to the three main areas of endeavor: development of a transport model for gas separation, development of small pore size ceramic membranes, and improvement of tests used to characterize the membranes. 2 refs., 2 figs., 2 tabs.

21134 (LBL–27805) **Fundamental studies of catalytic gasification: Annual report, October 1, 1988–September 30, 1989.** Heinemann, H.; Somorjai, G.A. Lawrence Berkeley Lab., CA (USA). Sep 1989. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. Order Number DE90008063. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Progress is reported on the role of catalysts during relatively low temperature steam gasification. This quarter, samples of three coals were obtained from IGT. These are the parent coals of the chars which have been used in earlier work. They comprise a subbituminous (Rosebud) and two bituminous coals (Ohio, Pitt #8 and Kentucky #13). An analysis of these coals is given. The coals were subjected to steam gasification at 640°C both in the absence of and in the presence of K–Ca–O catalyst. When the catalyst was used, it was impregnated on the coal by an aqueous nitrate solution containing equimolecular amounts of K and Ca. The procedure used and the nitrate decomposition treatment were the same as previously described for chars and graphite. In order to test the necessity of using relatively expensive potassium as a catalyst component, gasification of the Ohio Pitt #8 coal was undertaken employing a Na–Ca catalyst. A catalyst comprising cesium-calcium was also tested. 10 figs.

21135 (LBL–28266) **Reactive absorption of hydrogen sulfide by a polyglycol ether solution of sulfur dioxide.** Hix, R.M.; Lynn, S. Lawrence Berkeley Lab., CA (USA). Dec 1989. 120p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. Order Number DE90008464. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The absorption of hydrogen sulfide (H_2S) by a polyglycol ether solution of sulfur dioxide (SO_2) is but one step in a process under development to recover sulfur from sour-gas streams. The process makes use of the catalyzed, irreversible, second-order liquid-phase reaction between H_2S and SO_2, forming sulfur and water as products, to improve absorption rates in the primary absorber and to make it unnecessary to strip H_2S from ninety percent of the total solvent flow. As part of this development, tray efficiencies for both physical absorption of H_2S and $SO_2$and efficiencies for absorption with chemical reaction of H_2S are needed to design the absorbers in the process. Tray efficiencies were determined for physical absorption of H_2S and SO_2 on a single sieve tray at atmospheric pressure. Absorption rates were measured for absorption of H_2S followed by chemical reaction. 30 refs., 19 figs., 14 tabs.

21136 (LBL–28298) **Fundamental studies of catalytic gasification: Quarterly report for October 1, 1989-December 31, 1989.** Heinemann, H.; Somorjai, G.A. Lawrence Berkeley Lab., CA (USA). Dec 1989. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. Order Number DE90008389. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Progress is reported on the role of catalysts during relatively low temperature steam gasification. This quarter, catalyst dispersion was studied. A catalyst solvent for impregnation other than water was investigated to observe different wetting effects. A solution of 20% methanol in water was used to impregnate Kentucky #13 char with K–Ca oxide catalyst. Impregnation of Franklin Pitt #8 with other alkali and/or earth alkali oxides was also undertaken. Also this quarter, the initial KCa/C ratio was investigated for its effect on methane coupling after essentially complete gasification of the Rosebud char. The importance of the presence of water for the coupling reaction was studied at 640°C. In this case a relatively inactive $KCaO_x$ catalyst derived from impregnation on alumina wool was used, since large enough quantities of catalyst derived from char gasification were not available. Using the relatively low activity $KCaO_x$ catalyst on SiO_2, the effect of water flow and of temperature was also investigated. 12 figs., 1 tab.

21137 (ORNL/M–1081) **Permeability of membranes fabricated at ORGDP [Oak Ridge Gaseous Diffusion Plant].** Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90007451. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Two series of membranes wee fabricated ORGDP, and initial gas permeability measurements using these membranes have been completed. The first set consisted of six different membranes made from material A, having different pore sizes ranging from approximately 9 Å to 22 Å pore radius. The second set consisted of seven different membranes, made from material B, having different pore sizes ranging from about 7 Å to 18 Å. The permeabilities of the membranes were measured at room temperature using helium, nitrogen, and carbon dioxide. In addition, the permeabilities of the first set of membranes were also measured using air and sulfur hexafluoride. 15 figs.

21138 (PB–90-131541/XAB) **Coal gasification: An environmental, health, and safety overview. Topical report.** Skinner, F.D. Radian Corp., Austin, TX (USA). Jul 1989. 81p. (DCN–89-218-066-05). Available from NTIS, PC A05/MF A01.

This report presents an overview of the development of coal gasification technology and environmental, health, and safety issues associated with the technology that still remain to be resolved. The issues were identified as the result of a systematic analysis of the process units that may be present in a coal-to-substitute natural gas plant, their emission and discharge streams, and control and disposal options. A series of detailed process descriptions prepared as part of the GRI project served as the principal source of information in the development of the report.

21139 (PB–90-131665/XAB) **Production of gas fuel and chemicals by the gasification of waste solid and coal. Report for August 1986-July 1987.** Chou, T.C. National Cheng Kung Univ., Tainan (Taiwan). Dept. of Chemical Engineering. 1987. 10p. Available from NTIS, PC EE03/MF E03.

Coal is successfully gasified in the presence of a pilot flame in a modified fluidized bed. Except for the pilot flame, no external heat is required to operate the gasifier. The results showed that increasing the solid-to-air ratio in the feed increased the temperature and the products, carbon monoxide and hydrogen. About 95% of the volatile materials and 80% of the fixed carbon of the feed coal could be gasified by the pilot-flame gasification method. The ash could be efficiently separated during gasification by a distributor within the dead-zone collector of gasifier.

21140 (SAND–89-2399) **Hydrous metal oxide-supported catalysts: Part 1, Preparation chemistry and physical and chemical properties.** Dosch, R.G.; Stephens, H.P.; Stohl, F.V.; Bunker, B.C.; Peden, C.H.F. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 89p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90007607. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report describes the development of the following new catalytic materials based on hydrous metal oxide (HMO) ion exchange materials: Na-Ti, Nb, Zr, and mixtures of hydrated silica with hydrous Ti-oxide. HMO's provide a versatile system for the preparation of heterogeneous catalysts. The preparation chemistry allows synthesis of catalysts that can be tailored to particular processes with respect to both chemical and physical properties. Bulk catalysts with surface areas over 300 m^2/g and pore volumes up to 0.4 cc/g as well as thin films of the HMO materials can be prepared on supports having a wide range of catalytically important physical properties. This report, the first of two parts, presents research performed to date regarding the preparation chemistry, and physical and chemical properties of HMO materials which may be used to develop heterogeneous catalysts for direct coal liquefaction processes. During the course of this work, new ideas for research areas relative to direct coal liquefaction were briefly explored. Two of them that merit further work, catalyst-anchored hydrogen donors and alkoxide-derived crystalline titanate compounds, are briefly described. 25 refs., 34 figs., 8 tabs.

21141 (TAU–CPL8363-6/5475) **Classification of Canadian coals using pilot plant pressurized gasifier [part of the program of the Federal Panel on Energy R&D (PERD)]: Final report.** Transalta Utilities Corp., Calgary, AB (Canada). May 1987.

134p. Contract EMR 06SQ.23440-7-9134-1. (MICROLOG–90-00181). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Coal gasification in combination with combined cycle power (IGCC) generation is a new technology which offers the potential for the more efficient and environmentally acceptable utilization of coal for power production. When this project was proposed, only limited testing of Canadian coals for gasification applications had been carried out. To improve the background database on the gasification of Canadian coals, bench scale gasificiation tests were carried out using a pressurized fluid bed gasifier typified by the KRW process unit. One Canadian sub-bitumneous coal, three Canadian bituminous coals and one American bituminous coal, for comparison purposes, were used as feedstocks. The tests established the effects of air/coal ratio, temperature and operating pressure on gas heating value, gas yield, carbon conversion, cold gas efficiency and other performance indicators. The results showed that all the Canadian coals could be gasified and indicated the conditions for producing gases of the required heating value for IGCC. It was evident that the average coal feed rate is substantially lower, and the required temperature is higher, for gasifying the higher rank coals. Generally, the gas quality also decreases as the coal rank increases, other things being constant. The gasifier could be operated at a low air (or oxygen) to coal ratios for the more reactive coals, and at given ratio, all the bituminous coals yielded gas of similar heating value. The subbituminous coal was the most readily gasified and produced gases of a heating value of ca 4.7 MJ/m^3 at an air/coal ratio of 4. These results were comparable with pilot plant tests. 11 refs., 25 figs., 42 tabs.

21142 (WU/CE–90-00386) **Assessment of Waterloo flash pyrolysis process to obtain liquid fuels from Canadian peat.** Scott, D.S. Waterloo Univ., ON (Canada). Dept. of Chemical Engineering. Jun 1988. 162p. Contract EMR 24ST 23216-5-7138. (MICROLOG–90-00386). Available from PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A program was undertaken to evaluate the yields of liquids and other products obtainable from Canadian peats using the Waterloo Fast Pyrolysis Process (WFPP). A secondary objective was to investigate the short residence time fluidized bed as a dryer for milled peat. The pyroysis tests were carried out in the 1-3 kg/h pilot plant unit developed for biomass pyrolysis, in order to yield sufficient quantities of liquid for adequate characterization. Yields of organic liquids of about 45% to 47% of the moisture-free feed were obtained in the optimum temperature range of 450 degree to 550 degree with a younger long fibre sphagnum peat. Char yields decreased from 33% to 26% while gas yilds increased from 12% to 17% over the optmum temperature range. CO and CO_2 were the main gaseous products. The character of the liquid product changed significantly over the optimum temperature range. The ratio of water soluble to water insoluble components changed from 2.3 to about 0.6, with some corresponding decrease in oxygen content. A considerable number of the individual components were identified chromatographically. The short residence time fluid bed dryer was very efficient when tested for four grades of Quebec peat. For all but old decomposed black peat, which was more difficult to dry, with critical moisture contents of about 13%. Good yields of organic liquids can be obtained from yellow or brown peats using WFPP. These liquids have a lower oxygen content than oils from wood, and contain some longer chain paraffinic compounds. Upgrading tests showed that good yields of a gasoline-like liquid could be obtained by a catalytic deoxygenation-hydrogenation process. 17 refs., 36 figs., 3 tabs.

21143 Compositional aspect of iron Fischer-Tropsch catalyst: An XPS/reaction study. Kuivila, C.S. (Northwestern Univ., Evanston, IL (USA)); Stair, P.C.; Butt, J.B. *Journal of Catalysis (USA),* 118(2): 299-311 (Aug 1989).

The catalytic and compositional behaviors of prereduced and unreduced iron catalysts for Fischer-Tropsch synthesis were investigated. Catalytic behavior was evaluated by measuring rates of hydrocarbon formation 3:1 H_2:CO mixture at 1 atm and 250C. Iron phases which evolved near the catalyst surfaces were characterized by X-ray photoelectron spectroscopy, and bulk phases present following reaction were determined by Moessbauer spectroscopy. At low conversion levels the prereduced catalyst was gradually converted to iron carbide with no significant oxide phase formed. Synthesis activities increased initially with the formation of active surface carbon, but eventually lost some activity due to graphitic carbon formation. At higher conversions, the prereduced catalyst showed some formation of surface oxide phases and an inhibition of the synthesis rate due to water adsorption. Surface carbon accumulation was also suppressed under these conditions. Unreduced Fe_2O_3 showed no initial synthesis activity, but underwent a gradual activation to become even more active than the prereduced catalyst. The oxide catalyst was eventually completely reduced to Fe_3O_4, and any metallic phase formed was rapidly converted to iron carbide. Compared to reduced materials, the oxide catalyst accumulated considerably less surface carbon and showed no loss of activity for reaction times up to 48 h. XPS analysis suggests that Fe_3O_4 is active for synthesis.

21144 The effect of catalyst preparation on the performance of alumina-supported ruthenium catalysts. I. The impact of catalytic precursor on particle size and catalytic activity. Mieth, J.A. (Syracuse Univ., NY (USA)); Schwarz, J.A. *Journal of Catalysis (USA),* 118(1): 203-217 (Jul 1989). DOE Contract FG02-87ER13650.

The effect of preparation method and the choice of metallic precursor on the performance of a series of Ru/Al_2O_3 catalysts were studied. Wet impregnation and incipient wetness were the methods employed; ruthenium nitrosylnitrate and ruthenium trichloride were the reagents. In the latter case, either Ru(III)/Ru(IV) chlorospecies or mixtures of Ru(II) hydrazine complexes were the catalytic precursors. The series of Ru/Al_2O_3 catalysts, with metal loadings from 0.7-5% by weight, were subjected to a battery of performance tests: CO temperature-programmed reaction, steady-state CO hydrogenation, and temperature-programmed surface reaction. The methanation activity and carbon deposited during steady-state reaction varied systematically with the dispersion of Ru on the alumina. High rates of methane production were found on catalysts containing a large reservoir of carbon-containing reaction intermediates. The performance of these catalysts depended on the precursor used in their preparation. The effects of weight loading, method of preparation, and variations in the impregnant pH were small within a group prepared from a common precursor.

21145 The effect of catalyst preparation on the performance of alumina-supported ruthenium catalysts. II. The impact of residual chloride. Mieth, J.A. (Syracuse Univ., NY (USA)); Schwarz, J.A. *Journal of Catalysis (USA),* 118(1): 218-226 (Jul 1989). DOE Contract FG02-87ER13650.

The impact of residual chloride on the properties and performance of a series of Ru/Al_2O_3 catalysts has been studied. This work departs from previous studies in that it examines the poisoning and promoting effects of this electronegative element in CO hydrogenation as a function of the dispersion of the catalyst. The dispersion and structure of the particles are regulated by the choice of the precursor used during preparation and by the impregnation conditions. The authors find that, in general, chloride residues poison catalysts with a high dispersion but provide a promotional effect for catalysts with a poor dispersion.

21146 The role of lattice anion vacancies in the activation of CO and as the catalytic site for methanol synthesis over zirconium dioxide and yttria-doped zirconium dioxide. Silver, R.G. (Univ. of Texas, Austin (USA)); Hou, C.J.; Ekerdt, J.G. *Journal of Catalysis (USA),* 118(2): 400-416 (Aug 1989). DOE Contract FG05-86ER13604.

The role of lattice oxygen anion vacancy sites in the activation of CO and in the synthesis of methanol was investigated over ZrO_2. The study involved a comparison of the amounts of CO and SO_3 which adsorbed, the amount of methoxide which could be titrated from zirconia, and the rate of catalytic synthesis of methane and

methanol as a function of crystalline phase, calcination conditions, and Y_2O_3 levels in yttria-doped ZrO_2. Infrared and temperature-programmed desorption results established that CO adsorbed as formate and that SO_3 adsorbed as the sulfate $(ZrO)_3S{=}O$. Uptake studies over yttria-doped ZrO_2 demonstrate that SO_3 interacts with anion vacancy sites to form the sulfate. A maximum in SO_3 and CO adsorption and methanol titration occurred at yttria dopant levels where ionic conductivity is highest for yttria-doped ZrO_2. The correspondence between the amount of formate or sulfate adsorbed and the amount of methanol produced from the basis for concluding that surface oxygen anion vacancies are the catalytic sites for CO activation and methanol synthesis.

0105 Products and By-Products

Refer also to citation(s) 21362, 21363

0106 Properties and Composition

Refer also to citation(s) 21117, 21303, 22207

21147 (DOE/PC/88878–T5) **Coal surface control for advanced fine coal flotation: Quarterly report No. 5, October 1, 1989–December 31, 1989.** Fuerstenau, D.W. (California State Senate Water Resources Committee, Sacramento, CA (USA)); Sastry, K.V.S.; Hanson, J.S.; Narayanan, K.S.; Sotillo, F.; Diao, J.; Yin, Y.; Harris, G.; Somasundaran, P.; Harris, C.C. California State Senate Water Resources Committee, Sacramento, CA (USA); Columbia Univ., New York, NY (USA); Utah Univ., Salt Lake City, UT (USA); Praxis Engineers, Inc., Milpitas, CA (USA). 12 Feb 1990. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88878. Order Number DE90007229. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary goal of this research project is to develop advanced flotation methods for coal cleaning in order to achieve 90% pyritic sulfur removal at 90% Btu recovery, using coal samples procured from six major US coal seams. Concomitantly, the ash content of these coals is to be reduced to 6% or less. Investigation of mechanisms for the control of coal and pyrite surfaces prior to fine coal flotation is an important aspect of the project objectives. A second major objective is to investigate factors involved in the progressive weathering and oxidation of three base coals stored in three storage modes, namely, open, covered and in an argon-inerted atmosphere, over a period of twelve months. This quarter results are presented under the following topics: effect of ph modifiers on flotation performance; effect of anionic reagents during grinding; effect of organic monomers; effect of non-ionic reagents; grinding with collector and flotation kinetics; and flotation behavior of weathered coals. (CBS)

21148 (DOE/PC/88941–T5) **A study of coal particle shape and three-body wear: Quarterly report, November 1989–January 1990.** Clark, N.N.; Means, K.H. West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. [1990]. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88941. Order Number DE90007427. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The calibration of the three-body wear test machine is nearly complete. Preliminary tests have begun using two types of wear particles (silicon carbide and quartz). These tests are described. 4 figs.

21149 (DOE/PC/88951–3) **Determination of flow-regime boundaries for cohesive particles: Project 61093 Quarterly report, March 20–June 19, 1989.** Knowlton, T.M. Institute of Gas Technology, Chicago, IL (USA). Jan 1990. 32p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88951. Order Number DE90007425. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of this program is the development of a hydrodynamic model to predict the choking/non-choking flow regime boundary of fine, cohesive (i.e., Geldart Group C) powders. Specific objectives are: (1) to develop a two-dimensional hydrodynamic model which can be applied to cohesive solids; and (2) to generate large-scale, solids-flow data which will be used to verify the model. Results are discussed. 5 refs., 4 figs., 4 tabs.

21150 (DOE/PC/89780–T2) **[Basic properties of coals and other solids]: Quarterly report No. 2.** Arnett, E.M. Duke Univ., Durham, NC (USA). Dept. of Chemistry. 1988. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89PC89780. Order Number DE90008276. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The first report presented some heats of adsorption for a series of weak acids such as cresol, some alcohols and two esters on Carbopack F carbon. There was an excellent correlation between the heat of adsorption and the total polarizability (electronic polarizability plus orientation polarizability) for the adsorbate. Some preliminary heats of reaction for a series of substituted benzenesulfonic acids with slurries of polyvinylpyridine in acetonitrile were correlated with the corresponding heats of reaction of the acids with homogeneous solutions of pyridine in the same solvent. Report #1 also included some preliminary results for heats of interaction of various solids such as silica gel and three coals with solutions of triflic acid and methanesulfonic acid. These activities have been continued during the past quarter. The study of heats of reaction of cross-linked poly 4-vinylpyridine and pyridine at 25° in acetonitrile were continued. 2 refs., 2 figs., 3 tabs.

21151 (FSC–8903, pp. 1-4) **Influence of coal properties on pore structure of coke.** Igawa, Katsutoshi (Kawasaki Steel Corp., Tokyo, (Japan)); Kasaoka, Shizuki. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

Tensile strength and porosity of coke obtained by carbonizing coals of different properties were measured to study the evaluation of pore wall strength and the influence of coal properties on it. Five kinds of coal which have different fluidity and coal ranks were carbonized and the relation between measured tensile strengthes and porosities for each coke changed linearly. Since the difference of slopes of these straight lines is regarded as difference of porosity contribution to the coke matrix strength, this slope was defined as the abration index of coke pore wall to use as the parameter of pore wall strength and the relations between this index and fluidity or vitrinite averaged maximum reflectance were studied. When the influence of low grade coal blending on the coke strength was investigated, the abration index of coke pore wall increased linearly with the increase of low grade coal blending but the porosity changed hardly. Therefore, it is effective to improve the homogenity in the system by refining the size of low grade coal itself in order to increase the blending rate of low grade coal. 2 refs., 11 figs., 1 tab.

21152 (FSC–8903, pp. 5-8) **Effect of bulk density of charged coal on the distribution of CSR across the oven width.** Nishimura, Masaru (Kansai Coke and Chemicals Co., Ltd., Hyogo, (Japan)); Asada, Shingo; Uemura, Nobuo. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

On the chamber oven coke having large distribution for strength, the effect of bulk density of charged coal on the distribution of the strength across the oven width was studied. Nine kinds of sample coal were ground, carbonized with two levels of bulk density, namely, 750 and 850g/litre, Lump coke is divided equally into three parts at the oven width direction to designate head, body and tail in the order from the wall and CSR, CRI and porosity were measured to respective cokes. Following results could be confirmed: The distribution of porosity in the width direction is caused by the mass transfer to the width direction during carbonization and the degree can be arranged by the volatile matter in the charged coals. The distribution of CRI in the width direction does not change so large even if the bulk density of charged coals changes. Concerning CRS distribution, higher the volatile matter of charged coals and higher the CRI level, larger the CSR. 2 refs., 8 figs., 1 tab.

21153 (FSC–8903, pp. 19-23) **Characterization of various coals by FT-IR, ^{13}C CP/MAS FT-NMR and Raman spectrometry.** Moritake, Mitsuru (Osaka Gas Co., Ltd., Osaka, (Japan)); Matsumoto, Masaru; Yakawa, Chiori; Kobayashi, Shigeko; Nakamura, Takuji. Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

Aromatic hydrogen fraction, aromatic carbon fraction and factors which can represent the aromaticity for various coals of different coal ranks were investigated by applying an infrared absorption specroscopy(FT-IR), a nuclear magnetic resonance absorption spectroscopy with high resolution(^{13}C CP/MSA FT-NMR) and Raman spectroscopy to investigate the correspondence of these values to the coal ranks and interrelations between these vales. Recently, brown coal of low degree of coalification is used for hydrogasification or liquefaction reaction, so that 17 kinds of coal were selected to characterize ranging from brown coal to anthracite. Along with the increase of coal ranks, each measurement increased, indicating similar tendency(curves of chair type). It became clear that simple correlations are found respectively between aromatic carbon fraction, aromatic hydrogen fraction and Raman aromaticvity index. 8 refs., 8 figs., 1 tab.

21154 (IVO-B–01/89) **Heavy metal contents and natural radioactivity of fuel peat.** Lehtovaara, J.; Mustonen, R.; Penttilae, R.; Dernjatin, P.; Uotila, I. Imatran Voima Oy (IVO), Helsinki (Finland). Feb 1989. 42p. (In Finnish). Order Number DE90619463. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This study aimed at finding comprehensive information on heavy metal contents and natural radioactivie substances of fuel peat. The study concerned peat delivered to Imatran Voima Oy's Rauhalahti Power Plant in Jyvaeskylae and Joensuu Power Plant in Joensuu in the heating period 1986-1987. The bog-specific monthly samples were examined for arsenic, mercury, lead, cadmium, cobalt, chrome, zinc, nickel and copper contents. The uranium, thorium, and radium levels were studied separately. The comparison of the fuel peat by regions did not indicate any significant differences between Central and Eastern Finland. A comparison with the earlier results proved that the general level conforms to those found in the previous studies, but that the level of arsenic, mercury and uranium contents was higher, and the level of nickel content lower than found earlier. The contents of all the metals studied remained basically below 15 mg/kg in peat dry matter. In the comparison conducted between the various fuels the levels of the metals found in peat mainly were placed between those found in coal and heavy fuel oil.

21155 (PB–90-130154/XAB) **Health-hazard evaluation report MHETA 80-000-117, La Rosa Fuel Company, Clarksburg, West Virginia.** Engelberg, A.L. National Inst. for Occupational Safety and Health, Morgantown, WV (USA). 1989. 18p. (MHETA–80-000-117). Available from NTIS, PC A03/MF A01.

The National Institute for Occupational Safety and Health (NIOSH) evaluated possible hazardous working conditions at the La Rosa Fuel Company, Clarksburg, West Virginia. Particular attention was given to the prevalence of pneumoconiosis in the working population. Chest radiograph and spirometric testing was performed on the workers and a questionnaire was distributed dealing with occupational and smoking histories along with pulmonary symptoms. Of the 87 workers eligible to participate, responses were received from 70. Sixty of these men had no exposure to drilling and no evidence of pneumoconiosis was found among them. The other ten men had surface drilling experience. Three cases of silicosis were identified in these ten men. Acute silicosis associated with severe respiratory impairment was diagnosed in one and the other two had simple silicosis and normal lung function. Of 20 personal dust samples collected for these men, only 1 exceeded the Mine Safety and Health Administration limit of 2mg/cu m respirable dust. Recommendations were made based on an earlier study regarding means of controlling the dust generated on the job. Suggestions were also made for training and medical surveillance of workers.

21156 (PB–90-135450/XAB) **Permeability changes resulting from gas desorption. Final report, May 1988-June 1989.** Harpalani, S. Arizona Univ., Tucson, AZ (USA). Dept. of Mining and Geological Engineering. Oct 1989. 102p. Available from NTIS, PC A06/MF A01.

Permeability of coal samples, held under triaxial stress, was measured for increasing and decreasing gas pressure from 0 to 1000 psi, thus obtaining a pressure-permeability relationship. Experiments were carried out to establish the adsorption/desorption isotherms for powdered coal samples. Volume of coal matrix was monitored for increasing and decreasing gas pressure giving a pressure-volumetric strain relationship. Analysis of the results showed that associated with desorption of gas is a shrinkage of coal matrix. This shrinkage is in direct proportion to the quantity of gas desorbed. The shrinkage of coal matrix results in a significant increase in permeability of coal.

0108 Waste Management

Refer also to citation(s) 21168, 21170, 21175, 21577, 21660, 22290, 22611

21157 (DOE/PC/80512–T16) **Anaerobic sequencing batch reactor treatment of coal conversion wastewaters: Final technical report.** Ketchum, L.H. Jr.; Earley, J.P.; Shen, Yutao. Notre Dame Univ., IN (USA). Dept. of Civil Engineering. Sep 1989. 319p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80512. Order Number DE90006784. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The work proposed is a laboratory investigation of the AnSBR (Anaerobic Sequencing Batch Reactors) for treatment of a synthetic coal conversion wastewater. Two different strategies will be pursued. First, an AnSBR will be operated to simulate the Anaerobic Up-flow Sludge Blanket Reactor in an attempt to develop a readily settleable granular sludge. Second, operating strategies will be sought to optimize treatment, without attempting to develop settleable granular sludge. These systems will require development of more elaborate decanting mechanisms, probably including use of tube settler technology. We will use: (1) screening tests to identify compounds which are amenable to anaerobic degradation; (2) to determine those which are toxic or have an inhibitory effect; and (3) to identify the dilution required to achieve anaerobic degradation of the synthetic waste water; acclimation tests of organisms collected from different sources to the synthetic coal conversion wastewater; and Automatic Laboratory AnSBR studies. A 4-liter reactor will be operated to maintain a settleable granular anaerobic sludge when treating the synthetic coal conversion wastewater. 72 refs., 238 figs., 22 tabs.

21158 (EPRI-GS–6751) **Copper oxychloride as a fireside additive in coal-fired utility boilers: Final report.** Sanyal, A. (Babcock Energy Ltd., Crawley (UK)). Electric Power Research Inst., Palo Alto, CA (USA); Babcock Energy Ltd., Crawley (UK); Battelle Columbus Div., OH (USA). c Feb 1990. 121p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A plant trial to investigate the effects of copper oxychloride addition on wall slag formation was held during May/June 1986 on Unit 5, a 180 MW(e) boiler at PLEM Buggenum in Holland. The condition of the furnace surfaces was monitored visually, and comprehensive sampling of coal, ash and slag deposits and collection of boiler operational data were carried out. A consistent coal supply was maintained and the boiler operated at close to full load throughout the trial. The effect of copper oxychloride in controlling slag deposition has been clearly demonstrated, but it was not possible to establish the optimum dosage level nor to distinguish between the effects of intermittent or continuous dosage. From detailed microstructural examination of the slag deposits, some further corroborative evidence in support of the current theories of the model of action of the additive was obtained. The results of a pilot-scale study of the action of the additive are also reported. 8 refs., 12 figs., 19 tabs.

21159 (JAERI-M–89-177) **Removal of SO_x and NO_x in coal-fired flue gas by the addition of ozone and ammonia.** Namba, Hideki (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment);

Tokunaga, Okihiro; Suzuki, Nobutake. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 22p. (In Japanese). Order Number DE90759927. Available from NTIS (US Sales Only), PC A03/MF A01.

The addition of ozone and ammonia removed NO_x and SO_2 very effectively from simulated coal-fired flue gas which consists of NO (510 ppm), SO_2 (1030 ppm), H_2O (8 %), O_2 (15 %), and N_2 (77 %). The degree of NO_x removal and SO_2 removal was 87 % and 84 % respectively at 70deg C by adding 940 ppm O_3 and 3400 ppm NH_3. The main components of produced solid materials were identified to be NH_4NO_3 and $(NH_4)_2$ SO_4 by infrared absorption spectroscopy. The detailed reaction mechanisms of NO_x and SO_2 removals are discussed. (author).

21160 Design and construction of an advanced pressurized fluidized-bed warm unit. Mei, J.S. (USDOE Morgantown Energy Technology Center, WV (USA)); Rockey, J.M.; Ayers, W. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

As part of a fluidization research program, an advanced pressurized fluidized-bed warm (675 K) unit is being designed and constructed. The authors discuss how pressurized fluidized-bed combustion (PFBC) technology has advanced closer toward commercialization. This statement is supported by a growing number of significant PFBC technology developments. They report on a fluidization R and D program to explore the fundamentals and the applications of a pressurized circulating, fluidized-bed process to fossil energy conversion and utilization. This paper describes the salient design features of a 0.60-m diameter, pressurized fluidized-bed warm unit which will soon be commissioned. This advanced unit can be operated at pressure up to 500-kPa atmospheres and has been designed and instrumented for operation from a fixed-bed regime to a fast fluidization regime. The initial experimental effort on the characterization of flow regimes and their transitions at elevated pressure and temperature conditions is discussed in this paper.

0109 Environmental Aspects

Refer also to citation(s) 21595, 21596, 21914, 22510, 22576

0110 Reserves, Geology, and Exploration

21161 (IGT–90007522) **IGT world reserves survey: A survey of United States and total world production, proved reserves, and remaining recoverable resources of fossil fuels and uranium as of December 31, 1987.** Institute of Gas Technology, Chicago, IL (USA). c 1989. 344p. Sponsored by Institute of Gas Technology. Available from Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616 $30.00.

This report is an updating of previous IGT surveys of US and world conventional fossil fuel and uranium proved reserves and remaining recoverable resources. It also provides data on current and cumulative production of these nonrenewable energy sources and their life expectancies at selected annual consumption growth rates.

21162 (N–90-13880) **Summaries of the thematic conferences on remote sensing for exploration geology.** Environmental Research Inst. of Michigan, Ann Arbor, MI (USA). Oct 1989. 290p. (NASA-CR–185321;NAS–1.26:185321). Available from NTIS, PC A13/MF A02.

The Thematic Conference series was initiated to address the need for concentrated discussion of particular remote sensing applications. The program is primarily concerned with the application of remote sensing to mineral and hydrocarbon exploration, with special emphasis on data integration, methodologies, and practical solutions for geologists. Some fifty invited papers are scheduled for eleven plenary sessions, formulated to address such important topics as basement tectonics and their surface expressions, spectral geology, applications for hydrocarbon exploration, and radar applications and future systems. Other invited presentations will discuss geobotanical remote sensing, mineral exploration, engineering and environmental applications, advanced image processing, and integration and mapping.

0120 Mining

Refer also to citation(s) 21389

21163 (EUR–12292-EN) **ECSC coal research annual report 1988.** Wilkinson, J.K.; Luque, V. Commission of the European Communities, Brussels (Belgium). 1989. 159p. Available from Commission of the European Communities, Luxembourg.

An overview is presented of the scope of the European Coal and Steel Community coal research activities in the areas of: mine drivage, ventilation and climate, coal winning, mine infrastructure, management, coking of coal, and upgrading and conversion processes.

0130 Transport, Handling, and Storage

Refer also to citation(s) 21149

21164 (DOE/PC/90956–T9) **Advanced instrumentation for local measurement of gas-solid suspension flows: Quarterly technical progress report No. 11.** Ling, S.C.; Pao, H.P. Catholic Univ. of America, Washington, DC (USA). [1990]. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90956. Order Number DE90008498. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. GAS FLOW/measuring instruments; SOLIDS FLOW/measuring instruments; PROGRESS REPORT; VORTICES; PIPES

0140 Combustion

Refer also to citation(s) 21158, 22094, 22290, 22291

21165 (CONF-900107–2) **Corrosion assessment in FBC [fluidized-bed combustion] systems.** Natesan, K. Argonne National Lab., IL (USA). [1990]. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 4. Berkeley international conference on erosion-corrosion-wear of materials at elevated temperatures; Berkeley, CA (USA); 31 Jan - 2 feb 1990. Order Number DE90007806. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Metallic materials selected for the construction of heat exchangers and tube support structure in fluidized-bed combustion (FBC) systems must withstand the dynamic corrosive conditions prevalent in these systems. Oxidation-sulfidation interactions leading to accelerated metal wastage of components can occur owing to the presence of sorbent deposits on metal surface and/or the low-oxygen partial pressures in the exposure environment. A number of laboratory tests were conducted to examine the influence of deposit chemistry, gas chemistry, and alloy pretreatment on corrosion of high-chromium alloys, such as, Incoloy 800 and Type 310 stainless steel. Detailed chemical and physical analyses of spent-bed materials were made and correlated with the observed corrosion behavior of the alloys. A comparative analysis was made of the influence of bubbling-bed and circulating-bed deposits on corrosion of several candidate alloys. Finally, a comparison was made of the laboratory corrosion test data with the metal wastage information developed over the years in several FBC test facilities. 5 refs., 20 figs., 3 tabs.

21166 (CRIE-W–88026) **Prediction method of unburned carbon concentration in fly ash. Evaluation of combustibility by considering macerals in coal.** Kimoto, Masayoshi; Makino, Hisao; Akiyoshi, Hisashi; Nishida, Shinji. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1989. 29p. (In Japanese). Order Number DE90753096. Available from NTIS (US Sales Only), PC A03/MF A01.

In coal-fired power plants, it is very effective in the selection of coal rank and the establishment of combustion conditions to predict unburned carbon concentration in fly ash in advance from the coal

properties. A method to predict unburned carbon concentration in fly ash precisely from the coal properties on pulverized coal combustion, has been studied. Inertinite ratio (inertinite contain/exinite and vitrinite contains) was defined by evaluating combustibility of maceral groups which are called inertinite, exinite and vitrinite, it was adopted as influential factor to unburned carbon in fly ash. It was possible to evaluate residual rate of unburned carbon to combustible components in coal by considering both fuel ratio and inertinite ratio simultaneously, because it almost increased in proportion to inertinite ratio in case of selecting constant fuel ratio species. Furthermore, an equation for predicting residual rate of unburned carbon was prepared. It was revealed that predicted values of unburned carbon concentration were agreed well to experimental values. 4 refs., 9 figs., 6 tabs.

21167 (DOE/MC/23257–2801) **Acoustically enhanced combustion of micronized coal water slurry fuel: Final report.** Koopmann, G.M.; Scaroni, A.W.; Yavuzkurt, S.; Reethof, G.; Ramachandran, P.; Ha, M.Y. Pennsylvania State Univ., University Park, PA (USA). May 1989. 199p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23257. Order Number DE90000463. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A multi-faceted investigation has been carried out to demonstrate analytically and experimentally, that a high intensity acoustic field can be substantially enhance the convective transfer processes occurring during MCWSF (micronized coal water slurry fuel) combustion. The initial stage of the investigation dealt with elucidating the transient as well as time-averaged efforts of high intensity acoustic fields on the heat and mass transfer between a single spherical particle and its environment. A two-dimensional unsteady computer code was developed, which employs the unsteady conservation of mass, momentum, and energy equations for laminar flow in spherical coordinates. One objective of the present project was the modeling of MCWSF combustion in a laboratory scale combustor with and without the application of a sonic field. The influence of various operating parameters (sound frequency and level, etc.) on sonic enhancement could thus be studied. The combustion of pulverized coal (PC) was also modeled for the sake of comparison. The first of the two coal combustion experiments was performed using a flat flame methane-air burner. Micronized coal was injected in the same direction as, and burned together with the methane. The final investigation was carried out in a 300,000 Btu/h sonic combustor. For the runs conducted, SPLs of 156 dB and 145 dB, respectively, were measured below the fuel injection point and before the exit to the combustor. Frequency was held at 1400 Hz. Finally, an attempt was made to model the runs performed in the down-fired unit, using the PCGC-2 code. 61 refs., 60 figs., 8 tabs.

21168 (DOE/PC/88918–5) **Reduction of NO_x and SO_2 emissions from coal burning pulse combustors: Quarterly technical progress report, October 1, 1989–December 31, 1989.** Powell, E.A.; Zinn, B.T. Georgia Inst. of Tech., Atlanta, GA (USA). School of Aerospace Engineering. Jan 1990. 18p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88918. Order Number DE90008279. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This project is concerned with the reduction of the nitrogen oxides and sulfur dioxide emissions from Rijke type pulse combustors by using combustion staging and limestone addition. During this quarter an improved coal feed system was installed and the stationary coal bed was replaced with a rotating bed system. This resulted in greatly improved combustor performance by providing a uniform distribution of coal and by preventing agglomeration of ash during combustor operation. The gas analysis system was improved during the report period. A series of baseline tests was conducted to determine the behavior of the Rijke tube combustor under pulsating operation in the absence of measures to reduce NO_x or SO_2. Tests were conducted with the stationary bed for coal feed rates around 75 g/min for stoichiometric, excess air, and fuel rich conditions. A test with the rotating bed was conducted for stoichiometric conditions. Sound pressure levels, effluent gas compositions (CO_2, CO, O_2, NO_x, and SO_2), and gas temperatures at several levels above the bed were measured for all the tests. The tests with the stationary bed showed little effect of air/fuel ratio on NO_x and SO_2 concentrations for air/fuel ratios between 0.9 and 1.2. Here concentrations of NO_x and SO_2 averaged about 370 ppm and 1200 ppm respectively. The test with the rotating bed demonstrated the superior performance of this bed by increasing the pulsation amplitude by nearly 5 dB and by providing longer running times under more uniform combustion conditions. 10 figs., 1 tab.

21169 (EPRI-GS–6747) **Proceedings: Workshop on materials issues in circulating fluidized-bed combustors.** Electric Power Research Inst., Palo Alto, CA (USA). c Feb 1990. 668p. Sponsored by Electric Power Research Institute. (CONF-8906299–: Workshop on materials issues in circulating fluidized-bed combustors, Argonne, IL (USA), 19-23 Jun 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The workshop was designed to provide an informal opportunity for vendors and other interested parties to discuss their experiences with circulating fluidized beds (CFB) materials problems and their efforts at identifying solutions. Forty-five people representing thirty organizations from seven countries attended the workshop during the week of June 19, 1989 at Argonne National Laboratory. Session topics included the CFB environment, current R&D programs, experimental results and scale-up, experience of operating units, and solutions to materials problems. No materials problems were identified which would prevent further commercialization of CFB technology. The two major issues were tube wear at the waterwall-refractory interface in the furnace and refractory integrity in the hot cyclones. Thirty nine reports are presented. Individual projects are processed separately for the data bases.

21170 (PB–90-134578/XAB) **Current state of atmospheric fluidized-bed combustion technology.** International Bank for Reconstruction and Development, Washington, DC (USA). c 1989. 112p. (WORLD BANK TP–107). Available from NTISMF A01.

Library of Congress catalog card no. 89-22701. Microfiche copies only. Paper copy available from World Bank, 1818 H St., NW, Washington, DC 20433.

This paper examines atmospheric fluidized-bed combustion (AFBC) technology, a coal burning method that has several environmental and technical advantages over the more conventional technologies, such as pulverized-coal methods. The AFBC approach injects an air stream into a boiler in such a way that it mixes with solid fuel and sorbent to create a dense phase region or fluidized bed. This method makes it possible to use a much wider range of low-quality fuels and to burn them at lower temperatures with less pollutant by-product. The paper presents a comprehensive overview of AFBC technology to date. It includes worldwide development of this technology since the 1950s necessary to meet ever-stricter emissions requirements while providing greater fuel flexibility.

21171 FBC engineering correlations for estimating the combustion efficiency of a range of fuels. Daw, C.S. (Oak Ridge National Lab., TN (USA)); Chandran, R.R.; Duqum, J.N.; Perna, M.A.; Petrill, E.M. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract AC05-84OR21400. (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

Simplified engineering correlations are presented for estimating the combustion efficiency of a wide range of fuel types in fluidized bed boilers. The correlations are presented in such a way that they can be applied to various boiler designs, including both bubbling and circulating beds. Major emphasis is placed on minimizing the boiler design and operating details required, thereby enhancing the usefulness of these methods as screening tools. The impact of fuel type is addressed by making use of the fuel characterization parameters. It is demonstrated that the methods described give combustion efficiency estimates that agree well with typical observations from some well-documented fluidized bed combustion test facilities.

21172 Characteristics of erodent particles in fluidized bed combustors. Levy, A.V. (Lawrence Berkeley Lab., CA (USA)); Wang, B.Q.; Geng, G.Q. pp. 1382 of Proceedings of the 1989

international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract AC03-76SF00098. (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The authors report the erosivity of the various types of particles which occur in bubbling and circulating atmospheric fluidized bed combustors (AFBC's), determined as a function of the chemical and physical characteristics of the particles. Particles were obtained from five different combustors and included bed material, sand, limestone and precipitator ash. Tests were carried out at conditions which nearly simulated those in AFBC's. It is determined that several characteristics of the particles contributed to the metal wastage that occurred; among them were composition, shape, size and strength. The erosion of mixed bed material-iron oxide scales which formed on the target metal surfaces was the primary mechanism of metal wastage.

21173 **Multi-solids fluidized bed (MSFB) combustor: Modeling and analysis. .** Farag, I.H. (New Hampshire Univ., Durham, NH (USA). Dept. of Chemical Engineering); Breault, R.W.; Mongeon, R.K.; Hall, A.W. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The development of circulating atmospheric fluidized bed combustors (CFBC) has grown rapidly during the past few years. CFBC's are complex chemical reactors in which coal combustion, sulfur capture, and nitrogen oxide formation and destruction-takes place. Advanced coal combustion in CFBC is believed to be able to compete with oil fired boilers and to meet more strict emission limits. This paper discusses current research activities to develop an advanced concept atmospheric fluidized bed combustor. To characterize the performance of the dense bed and to interpret plant data, a model is developed for the lower fuel-rich fluidized bed part of the MSFB to predict pressure drop, particle size range, moisture evaporation, coal devolatilization, volatile combustion and char burnout. Model results are presented and discussed.

21174 **Measurement of alkali vapor concentration in PFBC flue gas.** Lee, S.H.D. (Argonne National Lab., IL (USA)); Carls, E.L. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

A potential problem with pressurized fluidized-bed combustion (PFBC) of coal is that the alkali metals in the flue gas will corrode the gas turbines. The authors report on a laboratory-scale PFBC/alkali sorber unit used to measure the level of vapor-phase alkali in PFBC (9.2 atm absolute) flue gas. Prior to sampling with a hot (850-900^{0}C) stainless steel tube for alkali analysis, the flue gas was cleaned of particulates by use of a hot cyclone and SiC candle filters. The alkali emissions from two different coal-sorbent combustions were determined. In the combustion of Pittsburgh Sewickley seam coal and Tymochtee dolomite at average bed temperatures of 900-925^{0}C, the alkali vapor concentration (Na + K) was measured by a real-time, on-line Ames alkali analyzer to be >50 ppbW in the PFBC flue gas. In the combustion of Beulah lignite and Tymochtee dolomite at average bed temperatures of 850-875^{0}C, the average sodium vapor concentration in the PFBC flue gas was measured to be 1.42, 1.51, and 1.31 ppmW by post-test analysis of sorber beds of activated bauxite (two beds) and diatomaceous earth, respectively.

21175 **Performance testing with high ash Indian coals and coal washery rejects in an AFBC pilot plant.** Krishnan, R.P. (Oak Ridge National Lab., TN (USA)); Anthony, J.; Rajavel, M.; Srinivasan, S.; Rao, A.J.; Rajaram, S. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract AC05-84OR21400. (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This paper reports on a research project in fluidized bed combustion (FBC) being carried out in India. The project is aimed at obtaining basic engineering data on the combustion of high-ash Indian coals (up to 45% ash), coal washery rejects (up to 70% ash), and high-sulfur (up to 5%) U .S. coals. Quantitative measurements of freeboard combustion, freeboard heat transfer, and freeboard gas composition are discussed.

21176 **Clean coal technology, another step in commercialization of FBC.** Carpenter, L.K. (Morgantown Energy Technology Center, Morgantown, WV (US)); Salvador, L.A.; Hemenway, L.F.; Hobday, J.M. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The United States Department of Energy (DOE) Clean Coal Technology (CCT) Program is discussed. It is an effort to demonstrate the commercial readiness of environmentally sound, coal-based technologies. This paper focuses on the commercial application of fluidized-bed combustion (FBC). The purpose of this paper is to provide an overview of FBC commercialization activities in the CCT Program. The background of this program, overviews of ongoing CCT FBC activities, and brief discussions of those FBC projects recently selected in the second CCT solicitation will be discussed.

21177 **The atmospheric fluidized-bed cogeneration air heater experiment.** Klein, A. (Rockwell International Corp., Canoga Park, CA (USA). Energy Technology Engineering Center); Natesan, K.; Podolski, W.F. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract W-31-109-ENG-38. (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The U.S. DOE-sponsored atmospheric fluidized-bed cogeneration air heater experiment (ACAHE) is intended to assess the performance of various heat exchanger materials. The resultant data is intended to help establish confidence in the designs of fluidized-bed combustion (FBC) air heater systems. This paper presents an overview of the project, a description of the facility and the test hardware, the test operating conditions, and a summary of the operation over the first 1000 h.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21421, 21887

21178 (CRIEPI–EY-89001) **Developing the inter-fuel competition model - an analysis of the structural changes of energy demand-supply in Japan.** Kumakura, O.; Nagata, Y.; Fujii, Y.; Matsukawa, I. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Sep 1989. 34p. Available from Central Research Institute of Electric Power Industry, Tokyo, Japan.

Under the stable oil prices after the sharp decrease in 1986, energy demand has turned to increase in Japan. And the composition of demands, which has been diversified by shifting from oil since the first oil crisis, seems decelerated at the same time. The trend of energy demand up to 2000 was examined with special attention to the two aspects; whether this high growth of energy consumption is temporary or not, and how the inter-fuel competition will progress. Simulation runs on 4 4 cases were conducted (Base Case, High Energy Price Case, CO_2 Emission Tax Case, and Deindustrialization Case). The results of the Base Case are summarized to the following two points, (1) energy demand will enter a long-term basic trend of increase because of the stable price of energy and the slowdown of energy conservation mainly in the industry sector, (2) demand for petroleum products will turn to increase as they have recovered price competitiveness. Through the sensitivity analysis,

the impacts of price effect and income effect of energy demand are analyzed, and the possibility to reduce CO_2 emission are evaluated when tax on fossil fuels will become imposed. 11 figs., 13 tabs.

21179 (LBL–28057) **Designing a performance based cost-sharing system for the Clean Coal Technology Program.** Kahn, E.; Stoft, S. Lawrence Berkeley Lab., CA (USA). Sep 1989. 48p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. Order Number DE90008050. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

To encourage participants in the Clean Coal Technology (CCT) Program to design and operate projects that will demonstrate performance objectives, DOE needs to examine the structure of its subsidy arrangements. The basic proposal examined in this paper is that subsides ought to be paid in proportion to actual project output, rather than as non-contingent grants. Paying for performance will induce the appropriate behavior from program participants. Under an arrangement of this kind participants meeting certain minimum technical thresholds can be selected by DOE by an auction. Those bidders who will accept the lowest performance subsidies will be selected. A simple model of bidder behavior is constructed which accounts for credit constraints, technical risk, and market returns. Analysis of this model reveals that credit constraints in the presence of technical risks are very significant. Potential lenders evaluate projects under "worst case" scenarios, whereas bidders make choices under expected value outcomes. Technical risk drives a wedge between these two perspectives. By structuring government subsidies in a purely "market-driven" fashion, i.e., paying only for performance, the cost to DOE of inducing desirable performance is high. A mixed system of grants and performance based subsidies is a more efficient approach of meeting both credit constraints and technology demonstration objectives. 16 refs., 5 figs.

0160 Health and Safety

Refer also to citation(s) 21138, 21895

21180 (PB–90-130659/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on coal mining before the Subcommittee on Energy and Power, House Committee on Interstate and Foreign Commerce, by Hohn F. Finklea, May 26, 1977.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 26 May 1977. 13p. Available from NTIS, PC A03/MF A01.

The statement concerned the occupational safety and health aspects of increased coal production, the conversion of oil- and gas-fired boilers to coal, and proposed coal conversion technologies. Studies continued to show that coal mining was one of the most hazardous occupations in the United States. Coal miners have excessive rates of chronic bronchitis and airway obstruction. Coal workers' pneumoconiosis continued to be a common finding in morbidity studies. Underground mining accounts for 82% of mining fatalities and 85% of nonfatal injuries. Increasing the production of coal would require that the coal-mining population be increased. Changes in mining techniques would also impact on the health of the miners. The introduction of diesel powered equipment into coal mines was of particular concern due to the possible health effects of long term exposure to a combination of coal dust and the gases and vapors of diesel exhaust. Conversion to coal-fired power-generation facilities would increase the public health hazards of emissions from coal combustion. Hazards to workers involved with large-scale coal-conversion technology included exposure to chemical carcinogens, toxic inorganic gases, noise, and heat stress.

21181 (PB–90-131020/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on coal mine health research before the Subcommittee on Labor Standards, House Committee on Education and Labor, by Edward J. Baier, June 29, 1977.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 29 Jun 1977. 15p. Available from NTIS, PC A03/MF A01.

The testimony discussed coal-mine health research efforts and technical assistance programs offered by the National Institute for Occupational Safety and Health (NIOSH) in support of protecting the health and safety of the miner. NIOSH has conducted research directed toward protection of life and health, detection of respiratory impairment, and prevention of occupational diseases of coal miners; established coal-mine health standards; and assured the availability of medical examinations for underground coal miners. Morbidity and mortality studies indicated that coal mining continues to be one of the most hazardous occupations in the United States, causing excessive numbers of cases of chronic bronchitis and airway obstruction, coal workers' pneumoconiosis, deaths due to accidents and assorted respiratory diseases, and excessive numbers of lung cancer and stomach cancer deaths. Studies and workshops related to the following topics are mentioned: effects of exposure to coal mine dust levels at or below the 2 mg/m^3 limit, introduction of diesel powered equipment, research gaps, hearing loss, the medical examination program for miners and the national Coal Workers' Autopsy study.

0170 Legislation and Regulations

Refer also to citation(s) 21178

02 PETROLEUM

Refer also to citation(s) 22296

21182 (PRM–CE02870, pp. 28) **The importance to Canada of Beaufort Sea resources.** Mitton, F. (Gulf Canada Corp. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Exploration activities spanning decades in the Canadian Beaufort Sea/Mackenzie Delta region culminated with the 1984 discovery and subsequent confirmation of between 700 and 800 million barrels of oil at the Amauligak location. Gulf Canada Corporation and its partners recently completed extended flow tests of the reservoir, and results indicate excellent reservoir characteristics with sufficient volumes of oil for Amauligak to become the lead Beaufort Sea production project. Although full development of Amauligak will not proceed until prices for crude oil increase and stabilize and appropiate regulatory and fiscal regimes are established, the Amauligak dicovery, like other frontier discoveries, remain important contributors to Canada's goal of oil self-sufficiencuy.

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 21161, 21162, 21210, 21291, 21352, 21383, 21932

21183 (BNL–43811) **A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field.** Senum, G.I.; Dietz, R.N.; D'Ottavio, T.W.; Goodrich, R.W.; Cote, E.A.; Spandau, D.J. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 67p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90007353. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A perfluorocarbon tracer (PFT) transport and dispersion experiment has been performed in the Ekofisk section of the North Sea oil fields. Fifty grams each of three PFTs were injected into a well and 28 surrounding wells were sampled for the presence of PFT. Sampling was accomplished by initially collecting bottles of reservoir hydrocarbon gas and subsequently transferring 5 liter (gas phase) aliquots onto Capillary Adsorbent Tracer (CAT) samplers. The resulting CATS samplers were analyzed for PFT in a specially configured laboratory gas chromatograph with electron capture detection. The limit of detection for PFT as determined by standard addition experiments was circa 1 to 10 femtoliters (10^{-15} L) per liter of sampled reservoir gas. Sampling was performed up to two years past the injection time; approximately two hundred samples were analyzed. PFT was performed only in four sampling wells at four different times, though the PFT analysis of earlier samples

lack sufficient sensitivity to PFT detection due to a hydrocarbon interferent problem which was resolved during this experiment. The PFT concentrations observed in these four wells appeared to follow an exponential dilution law with a dilution half-life of approximately 70 days in the reservoir. Recommendations for future experiments of this nature are made based on the problems encountered in this initial study. 4 refs., 28 figs., 10 tabs.

21184 (CONF-850710–, pp. 73-83) **An estimate of world resources of heavy crude oil and natural bitumen.** Meyer, R.F. (Geological Survey, Denver, CO (USA)); Schenk, C.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The total estimated resource in place of heavy crude oil and natural bitumen in the world ranges from 6,214,973 million to 6,277,400 million barrels. The amount of recoverable heavy oil and natural bitumen is estimated to be considerably smaller, possibly 540,000 million barrels of heavy oil, and approximately 350,000 million barrels of natural bitumen. Most of the worlds natural bitumen (about 75%) occurs in Canada, and approximately 22% of the world total is in the Soviet Union. The remaining 3% is distributed among 18 other countries. Almost 99% of the worlds natural bitumen is in a few giant deposits (those containing greater than 1,000 million barrels in place) in Canada, The Soviet Union, the US, Nigeria, Angola, and Chile. Many countries have unevaluated deposits of natural bitumen, but most of these occurrences appear to be small. Heavy oil has a wider geographic distribution of known reserves than bitumen, but most of the heavy oil is found in a few countries, such as Venezuela (65%), Kuwait (10%), and the US (3%). Most of the postulated undiscovered heavy oil is in Venezuela, Iraq, the Soviet Union, and the US.

21185 (CONF-850710–, pp. 135-142) **Distribution and geological characteristics of heavy oil in China.** Gu Xinzhang (Scientific Research Institute of Petroleum Exploration and Development, Beijing (China)); Zhang Yirong. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Chinese heavy oil is characterized by high viscosity and high gravity. It is widely distributed in Mesozoic and Tertiary formations in the Liao He, Daguang, Shan Li. and Xingjiang oilfields. In general, the light fractions account for less than 10% in these oils. Asphaltene and resin accounts for 25 to 50%, with sufur, oxygen, and nitrogen often included. This composition affects the properties of the heavy oil. The gravity and viscosity, expecially, change with the asphaltene-resin contents. The heavy oil usually accumulates on the margins of petroleum-generating basins and is concentrated in up-dip edges of shallow formations. Generally, the oil becomes heavier from deep to shallow depths. In some cases, it is controlled by a fault system, an unconformity, or sedimentary faciles. The heavy oil can only impregnate peripheral permeable and fluvial facies, consisting of coarse sandstones or fine conglomerates. Sometimes porosity can reach 30% and permeability, several thousand millidarcies. Most heavy oil is buried at depths of less than 1800 meters, occassionally to 2500 meters.

21186 (CONF-850710–, pp. 143-148) **Exploration for heavy crudes in Guatemala.** Rosales, D.; Diaz, H.N.; Paredes, C.; Rodriguez, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Oil exploration in Guatemala started in the 1950s and oil exploitation started in 1980. Today, four sedimentary basins have been defined in the country. The oil discoveries in Guatemala have such a variable API gravities that a tendency of this property for the crudes has not yet been established. Thus far, the heaviest crude oil (16°API) is located in a shallow reservoir in the Paso Caballos Basin.

21187 (CONF-850710–, pp. 149-159) **Occurrence of heavy crude oil in Cambay Basin, India.** Rao, K.L.N. (Oil and Natural Gas Commission, Ankleshwar (India)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In the northern part of the petroliferous Cambay Basin of western India, heavy crude oil occurs in Middle Eocene sands entrapped by stratigraphic-structural conditions. The oil is in a north-south linear belt of 26 km fringing a prominent structural horst (Mehsana horst) on its eastern flank. The heavy oil is in the sands of Kalol formation (Middle Eocene-Upper Eocene), which is oil-bearing over a large area of the northern Cambay Basin. The oil sands are deposited as thick clastic wedges on the flanks of the structural horst by meandering channels of a paleodelta system. The Kalol formation, 450 m maximum in thickness, contains silty sand, shale, and coal alternations. It thins rapidly towards the Mehsana horst in the north, where it is 125 m thick, with shales and thick sands (70 m), clearly indicating the direction of sand entry into the basin through a delta system. Though the heavy crude oil is in a continuous sand, the oil is placed in different oil fields, based on the crude oil characteristics. In the southern part of the belt, the oil occurs at –990 m in Santhal field and in the northern part at – 1,036 m in Lanwa field. The oil properties deteriorate from south to the north. In Santhal field, the oil has a specific gravity of 0.95 and a viscosity of 60 cp, changing to a specific gravity of 0.977 and a viscosity of 500 cp in Lanwa field with an intermediate value of 100 cp in between. From south to north, the gas-oil ratio (GOR) decreases from 23 vol/vol to a low value. The reservoir properties of the sand remain unchanged over the entire oil belt, with a porosity of 25% and permeability of over 2 darcies. Due to a thick column of water underlying the oil column, the reservoir pressure is uniformly hydrostatic in the oil pool.

21188 (CONF-850710–, pp. 171-183) **The occurrences of heavy crude and tar sands in Indonesia.** Dalem, M.A.W.; Padmosubroto, S. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Heavy crude in Indonesia varies from 16°-25°API. Ten oil fields produce heavy crude oil and one produces tar sands oil. The total original oil in place of heavy crude oil (excluding tar sand) in Indonesia is estimated to be 7.8 billion stock tank barrels, with Duri being the largest field. The original oil in place of the Duri field is

currently estimated 7.1 billion stock tank barrels. Ultimate primary oil recovery is approximately 11%. To enhance the oil recovery in this field, a steamflood project is currently being implemented and, based on the studies that have been conducted so far, ultimate oil recovery is expected to increase to approximately 55%.

21189 (CONF-850710–, pp. 185-189) **Geology and reservoir characteristics of the Tsimiroro heavy oil deposit.** Andrianasolo, H.R. (Office Militaire National pour les Industries Strategiques, Antananarivo (Madagascar)); Raveloson, E.; Razafimbelo, E.; Lalaharisaina, J.V. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

To achieve energy independence the Malagasy Government has undertaken the evaluation of the Tsimiroro heavy oil deposit. Located in the northwest of the island, the oil deposit has been known since the last century, but oil prospecting has been sporadic. To date, 47 wells have been drilled in the Tsimiroro area. They have provided detailed information and thus a better knowledge of the deposit, including geology, physico-chemical characteristics of the formation, and fluid. Recently, a resevoir simulation study by steam soaking was done.

21190 (CONF-850710–, pp. 191-207) **Major tar sand and heavy oil deposits of the United States.** Kuuskraa, V.A. (Lewin, ICF, Inc., Washington, DC (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents a current assessment of US tar sand and heavy oil resources. It is based on an independent appraisal of all tar sand deposits with 100 million barrels in place or more and the construction of a heavy oil reservoir and data base of fields containing more than 20 million barrels in place. The US tar sand resource is estimated to be 63 billion barrels, distributed in 11 states. This resource estimate is considerably larger than reported in previous studies, which had estimates ranging from 5.5 to 36.4 billion barrels. No estimate is available of how much of this resource is recoverable. The US heavy oil resource is estimated to be about 100 billion barrels in place. With advanced extraction technologies, as much as one quarter of this resource, or 24 billion barrels, may be recoverable.

21191 (CONF-850710–, pp. 209-220) **Heavy oil reserves in the Monterey Formation offshore California - Geological and engineering aspects.** Heck, R.G. (Ogle Petroleum Inc., Santa Barbara, CA (USA)); Mannon, R.W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Recent exploration of Monterey formation prospects offshore California has been highly successful, resulting in the discovery of 3.5 billion barrels of heavy oil reserves. Present known plans will bring approximately 2 billion barrels of these new reserves into production late in this decade and the early 1990s. Improved E-log analytical techniques and drill-stem test procedures are beginning to provide better data on Montery reservoir characterisitics, but such data are still to sparse to provide an adequate base for accurate reservoir predictions. Recovery parameters related to net pay or initial oil in place the Monterey are more meaningful, but only available after detailed petrophysical and reservoir analysis. From the limited production history of new offshore fields and released information of exploratory wells, the Monterey formation regionally appears to have better reservoir characteristics offshore than onshore.

21192 (CONF-850710–, pp. 221-237) **Exploration and evaluation of the Orinoco oil belt final results.** Fiorillo, G.J. (Petroleos de Venezuela, Caracas (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In 1978, after the nationalization of the oil industry, the Venezuelan Government entrusted Petroleos de Venezuela, S.A. (PDVSA) with the responsibility of continuing the exploratory evaluation of the Orinoco Oil Belt (OOB), establishing 1983 as the deadline for the conclusion of the evaluation. The geophysical programs produced data of wide coverage and, in the majority of cases, sections with very good seismic resolution from which were obtained reliable interpretations for structural control of the wells. Regional geological models were made to define the main oil accumulations. The use of modern petrophysical techniques allowed the solution of problems related to the fluid distribution in the formations. Computerized evaluations methods were applied to extensive areas, and covered a large number of wells. Geochemical analysis of the crudes also contributed to the evaluation of the fluid content of the accumulations. Through the analysis of cold oil production tests and subsequent steam soak performance, the areas of interest for future development, containing sufficient reserves and accumulation characteristics to permit production planning were duly identified.

21193 (CONF-850710–, pp. 239-269) **Geology of a single well (Maraven SDZ-86X) from cores and logs, Faja Petrolifera del Orinoco, eastern Venezuela.** Pirie, R.G. (Schlumberger-Doll Research, Houston, TX (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This study of the MARAVEN SDZ-86X well was made under an agreement between INTEVEP, MARAVEN, and Schlumberger-Doll Research (SDR) within the Petrophysical Program on the evaluation of the Faja Petrolifera del Orinoco in eastern Venezuela. The MARAVEN ADZ-86X well is located 43 km due east of Zuata and the northeast-southwest-trending Zuata River, which marks the border between the State of Guarico on the west and Anzoategui on the east. The well was drilled to 2360 feet and whole-cored from 1536 to 2232 feet, with a recovery of 87%, penetrating the Upper Tertiary sediments of the heavy oil-bearing Oficina Formation. In addition to the whole core geological-petrophysical analyses provided by Koninklije/Shell Exploratie en Produktie Laboratorium (KSEPL) in Den Hague, Netherlands, SDR collected 118 sidewall cores (94% recovery) and analyzed for the following: grain size, bulk and clay mineralogy, cation exchange capacity, and chemical elements by neutron activation. In addition, SDR performed x-ray radiographic and photographic analyses on 43 two-third cut, frozen, whole cores provided by KSEPL.

21194 (CONF-850710–, pp. 271-285) **Types of oil accumulations in the Hamaca area, Orinoco heavy oil belt.** Funes, D. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper discusses the different types of oil accumulations and their trapping mechanisms in the Hamaca area. The area presents a clearly defined change of slope at basement level which causes a change in the dip of the beds (hinge line). This hinge line separates the Hamaca area into two provinces with distinct geologic characteristics. These areas are referred to as Hamaca North and Hamaca South. The hydrocarbon accumulations have been divided into two main categories, according to size, regional extent, and nature of the accumulations. These categories have been denoted as first and second order accumulations. First order accumulations are those formed by progressive butting of basal sands of the Oficina formation against the basement. This occurs in the South Hamaca area. Second order accumulations occur in lenticular sands of moderate thickness, with mixed structural-stratigraphic trapping mechanisms.

21195 (CONF-850710–, pp. 287-303) **Petrophysical evaluation of the Orinoco Heavy Oil Belt area Hamaca-Pao.** Pilman, D. (MENEVEN, Caracas (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper deals with the petrophysical evaluation of wells located in the Hamaca-Pao area assigned to S.A. MENEVEN, one of the four affiliates of Petroleos de Venezuela, S.A. operating in the Orinoco Heavy Oil Belt. The object of this study is to provide a complete petrophysical evaluation of wells located in that new area in order to obtain representative parameters required for future reservoir and geological studies, leading to accurate calculations of volumes of hydrocarbons in place. The petrophysical evaluation was performed with a computer program using the Waxman-Smits equation for shaley sands and Archies equation for clean formations. The input data were obtained from a suite of logs (induction/spontaneous potential/gamma ray or dual laterolog/microspherical/gamma ray and formation density/compensate neutron/gamma ray) recorded in 114 wells. One of the critical parameters of the evaluation, the formation water resistivity (Rw), was well known for the area, as extensive measurements were obtained on free water samples. In each well the petrophysical evaluation was made on all sands present in the formation, and included lignite count, fluid saturation (hydrocarbon/water), porosities, permeabilities, and a net oil-sand count for each interval. Results were compared with parameters obtained from two key cored wells and were satisfactory. Hence, it can be concluded that the method used in conjunction with the logging program appears adequate for fast and massive evaluation of data.

21196 (CONF-850710–, pp. 305-316) **LAGOVEN's heavy oil fields of southern Monagas, eastern Venezuela basin.** Jam, P.L. (LAGOVEN, S.A., Caracas (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A string of nine heavy oil fields stretches along the southern part of the state of Monagas, eastern Venezuela, forming the northern rim of the Orinoco Heavy Oil Belt. All these fields are operated by LAGOVEN S.A., one of the four affiliates of PDVSA, the Venezuelan national oil company. This string of fields starts on the west with El Salto field, followed successively to the east by the Morichal, Jobo, Temblador, Pilon, Uracoa, Isleno, Bombal, and Tucupita fields, reaching the western margin of the Orinoco River delta. The general stratigraphic and structural characteristics of the nine fields are similar with minor differences among them, due to variations in oil gravity, sand thickness, and local structural features. All of them produce from the Oficina formation, of Miocene age, and the trapping mechanism is mainly structural. The oil gravity varies from 20° API in the Temblador field to 9°API in the Morichal field. In this field, as well as in Jobo immediately to the west, two oil segregations are present. The production mechanism is a combination of water drive, gravitational segregation, and, probably, rock compaction. The wells produce by natural flow, pumping, and gas lift. Since 1980 LAGOVEN has been developing two steam injection pilot projects in the Jobo field, in the C and G sands of the Morichal member of the Oficina formation. Geological details of the project are given in this paper.

21197 (CONF-850710–, pp. 317-335) **An integrated development plan for the Zuata area of the Orinoco heavy oil belt.** Burkill, G.C.C.; Riascos, A.J. United Nations Development Programme, New York. NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The exploration activity by MARAVEN in Zuata, an area of 14,500 km^2, commenced in late 1979 and was completed by mid-1983 after the drilling of 161 wells supported by 6000 km of seismic line and 302 production tests. The results indicated a STOIIP of 500,000 million barrels with oil gravities between 6° and 19°API in a productive area of 9,200 km^2. A priority area of 3,500 km^2 was defined, based on crude quality and reservoir characteristics, containing 250,000 million barrels of crude in the range of 8°-11° API. The further evaluation of the area is based on two steam soak pilot projects, one consisting of a steam soak cycle of injection/production in 16 wells dispersed over the productive area, of which 12 are already injected, showing initial stabilized productivities in excess of 1000 b/d. A second pilot is programmed to define the production performance and reservoir behavior under commercial exploitation. Finally, a conceptual development plan using well clusters and steam soak has been proposed in modules of 100,000 b/d with transportation and export of the Zuata crude from an existing marine terminal situated 300 km from the field.

21198 (CONF-850710–, pp. 393-402) **The interaction of hot geothermal brines and crude petroleum.** Barnea, J. (Information Center for Heavy Crude and Tar Sands, New York, NY (USA)); Omana, R.; McDavid, R.; Yen, T.F. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper attempts to explain the origin of heavy oil by looking at tectonic activity originated by plate tectonics. The incorporation

of trace metals to produce heavy oil is explained in this report by geothermal and volcanic interactions with the light oil. The authors diverge from the actual diagenesis concepts to conclude that current theories do not explain the presence of vanadium, nickel, and other trace metals in the accumulations of heavy oil in the world. The proposed diagenesis model shows the mixing and flooding of geothermal brines in zones where light oil or organic kerogen deposits are contained in the rock. Experiments in the laboratory, under oxidizing and nonoxidizing conditions simulating this action, produced a heavy oil that has incorporated the minerals contained in the brine. The results obtained under oxidizing conditions indicate a higher content of asphaltenes and, at the same time, an increase of viscosity and density. A very hard bituminous material (carboid) associated with coal and graphite was formed under nonoxidizing conditions. The presence of vanadium, nickel, and other trace metals at different concentrations in the overburden, in bitumen, as well in tar sand, is explained by the flooding of geothermal brines through the formation. The arguments in this article lead to the conclusion that geothermal resources and volcanic occurrences should be considered pathfinders for exploration of heavy crude accumulations. Geothermal gradients, solubilization of oil in water, emulsion transport, catalytic activity of clays, bacterial activity, and formation of metal complexes are discussed by the authors to visualize a more generalized diagenesis mechanism.

21199 (CONF-850710–, pp. 403-409) **The role of lithology in the generation of heavy oils: A laboratory simulation study.** Huizinga, B.J. (Univ. of California, Los Angeles (USA)); Tannenbaum; Kaplan, I.R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A series of dry pyrolysis experiments, utilizing 2 different immature kerogens (from the Miocene Monterey formation and the Eocene Green River formation) mixed with common sedimentary minerals (calcite, illite, and montmorillonite), was performed in order to study the catalytic and adsorptive properties of minerals during petroleum generation and release. Pyrolysis of kerogen with calcite, illite, or alone produces approximately the same quantities of total extractable bitumen and a similar trend of increasing C_{12+} saturated and aromatic hydrocarbons with progressive thermal maturation. Kerogen heated alone and in the presence of calcite yields approximately equal quantities of both C_{12+} saturated and aromatic hydrocarbons. Lower to equal amounts of these hydrocarbons are produced in the presence of illite. In contrast, kerogen heated with montmorillonite produces notably lower quantities of generated bitumen as thermal maturation progresses and C_{12+} saturated hydrocarbons undergo rapid, nearly complete destruction. The decrease in bitumen during pyrolysis of kerogen with montmorillonite is accompanied by a substantial increase in hydrocarbon gases and condensates, which indicates a strongly catalytic cracking of larger organic constituents, and production of polymerized solid product (pyrobitumen). Montmorillonite and illite display strong adsorption capacities for dominantly polar compounds. Calcite, however, possesses a weak or no adsorptive capacity.

21200 (CONF-850710–, pp. 421-431) **Advance in cased hole logging - The multiparameter spectroscopy instrument continuous carbon/oxygen log (MSI C/O).** Chace, D.M. (Dresser Industries, Inc., Houston, TX (USA)); Schmidt, M.G.; Frost, E.; Fertl, W.H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Carbon/oxygen (C/O) logging technology is particularly suited for reservoir rocks containing fresh, brackish, or unknown formation water salinities, i.e., conditions not amenable to normal macroscopic cross section measuring devices. The commercial introduction in 1984 of a new and improved C/O device, the Multiparameter Spectroscopy Instrument (MSI C/O) advances this technology even farther. This paper focuses on the advances made in measurement reliability and interpretation through use of the MSI C/O device. Novel, previously unavailable measurements are discussed in light of their added information concerning both borehole and formation properties in cased wellbores. Recent field examples of the MSI C/O are presented to support the discussion, with special focus on heavy oil evaluation.

21201 (DOE/BC–89/1/SP, pp. 33.1-33.29) **Feasibility study for a well to well electromagnetic prospecting technique.** Passalacqua, H.M. (Intevep, S.A., Los Teques (Venezuela)). USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

A numerical modelling was carried out in order to analyze the feasibility of well to well arrays for oil exploration or production. Parameters like source-receiver separation, transmitters frequency, source and receiver depth relative to the geological model, anisotropy and others, were considered. The most practical approach seems to be the use of a vertical linear source because it produces a more homogeneous and stronger primary field.

21202 (DOE/IE/10574–T1) **Radar imagery interpretation to assess the hydrocarbon potential of four sites in the Philippines: [Final report].** Arkansas Research Consultants, Inc., Fayetteville, AR (USA). 17 Nov 1988. 208p. Sponsored by U.S. DOE Management & Administration. DOE Contract FG01-87IE10574. (ARCI-TR–8701-101). Order Number DE90008470. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The Government of the Republic of the Philippines has invited new bids from international companies to explore for oil and gas in onshore and offshore sedimentary basins. To assist the private oil industry in the evaluation of the petroleum potential of these basins, the Government, with the assistance of a loan from the World Bank has completed a nation-wide basin evaluation program. The primary objective of the project is to further the goals of international energy development by aiding the Republic of the Philippines in the assessment of potential petroleum prospects within the areas imaged by radar. Secondary goals are to assist the Republic of the Philippines in utilizing state-of-the-art radar remote sensing technology for resource exploration, and to train key Philippines scientists in the use of imaging radar data. Geologic maps were prepared for each petroleum prospect region and are included in this report. A discussion on radar principles, lithography, and stratigraphy of the areas is also included. 29 refs., 27 figs., 12 tabs.

21203 (OMNR–90-00837) **Oil and gas exploration, drilling production summary, 1986.** Oil and gas, Paper 9. Carter, T.R. Ontario Ministry of Natural Resources, Toronto, ON (Canada). 1989. 136p. (MICROLOG–90-00837). Available from PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual summary was compiled from records submitted by licensed operators and covers the calendary year 1986. The report covers leasing licenses and activity onshore in southwestern Ontario, offshore in Lake Erie, and in the Hudson and James Bay lowlands; geophysical and geochemical activity; drilling licenses, permits and activity; production of oil and natural gas; and natural gas and salt cavern storage. An explanation of the operations and organization of the Section are included, as well as a listing of licenses issued and a summary of wells drilled. Highlights include a significant drop in activity, with only 113 wells drilled in all of Ontario. Four development wells were drilled in Lake Erie, all completed as gas producers. Drilling on land decreased only 10%

however. Onexco, the exploration division of the Ontario Energy Corp., was wound down and its assets put up for sale. Coincident with deregulation of the natural gas industry, the Ontario Energy Board removed the operations of the exploration and development department of Consumers' Gas Company Ltd. from the regulated portion of the utility.

21204 (PRM–CE02870, pp. 13) **The vagaries of Arctic exploration.** Maciej, H. (Canadian Petroleum Association (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

An overview is presented of oil industry exploration in the Canadian Arctic from the earliest discoveries at Norman Wells through the first Mackenzie Delta gas discoveries, the influence of developments in Alaska, the oil crisis of the 70s and the governmental policy responses, to the current declining state of the oil market. The large oil price increases between 1973 and 1981 did open an economic window for many of Canada's marginal resources, but lower oil prices have made Arctic regions less attractive to the industry. A long recovery period is expected, with interest and debt repayment being the industry's first priority, followed by development drilling to maintain production and lease commitments. Exploration drilling will be high-graded to reduced risk and will thus be at a very low level.

21205 (SAND–89-2297C) **The long-term measurement of strong-motion earthquakes offshore southern California.** Sleefe, G.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 19p. Sponsored by U.S. DOE Defense Programs; U.S. Department of the Interior. DOE Contract AC04-76DP00789. (CONF-900507–1: 22. offshore technology conference and exhibition (OTC-22), Houston, TX (USA), 7-10 May 1990). Order Number DE90007071. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a new long-life Seafloor Earthquake Measurement System (SEMS) and presents earthquake data obtained from the seafloor near an offshore oil production field. The SEMS is a battery-powered (8 year life) digital data acquisition system which telemeters data via a sonar link. Seafloor earthquake data from SEMS indicate that the seafloor vertical acceleration is nearly an order of magnitude weaker than the corresponding on-shore vertical motions. The importance of the SEMS measurements in designing earthquake-resistant offshore structures is also described. 13 refs., 6 figs., 1 tab.

21206 (UCID–21859) **FORTRAN programs for basin analysis and petroleum generation modeling.** Sweeney, J.J. Lawrence Livermore National Lab., CA (USA). Dec 1989. 43p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. Order Number DE90008121. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Vitrinite reflectance is a commonly-used thermal indicator in the analysis of the thermal history of geologic basins and has become, in the petroleum industry, practically synonymous with the maturity level of the hydrocarbons in the basin. The Petroleum Geochemistry Group at LLNL have recently developed a kinetic model of the maturation of vitrinite reflectance with depth for the thermal history of a well. We now use these calculations to check the geologic thermal history models for consistency with measured vitrinite reflectance data. VITMAT is primarily designed to generate a time-temperature history, for a given well stratigraphy with known sediment properties, in the simple situation where there are no unconformities or periods of uplift or nondeposition. The thermal history is also used in VITMAT to calculate the vitrinite reflectance at the base of each formation modeled. BASINVIT and BASINMAT2 are applied in the case where a time-temperature history has already been derived by some means and it is input to each program. In this mode the programs can deal with any type of thermal history, including nondeposition (indicated by constant temperature). BASINVIT uses a kinetic reaction scheme with a distribution energies to calculate the vitrinite reflectance each time there is a change in the heating rate in a given model. BASINMAT2 also uses a given time-temperature history as an input, but it calculates the vitrinite reflectance only at the present day. 8 refs., 11 tabs.

21207 **Elastic and viscoelastic calculations of stresses in sedimentary basins.** Warpinski, N.R. (Sandia National Labs., Albuquerque, NM (USA)). *SPE (Society of Petroleum Engineers) Formation Evaluation (USA),* 4(4): 522-530 (Dec 1989). DOE Contract AC04-76DP00789.

This study presents a method for estimating the stress state within reservoirs at depth with a time-history approach for both elastic and viscoelastic rock behavior. The model can incorporate changes in pore pressure, temperature gradients, consolidation and diagenesis through time-varying material properties, and varying tectonic episodes. Example calculations are presented for simple cases and for a complete stress history of rocks in the Piceance basin.

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Refer also to citation(s) 21189, 21191, 21192, 21193, 21196, 21197, 21203, 21311, 21312, 21315, 21355, 21361, 21397, 21405, 21409, 21410, 21412, 22113, 22114, 22294

21208 (CONF-850710–, pp. 25-32) **Economics of heavy crude production by enhanced oil recovery in Europe and Africa.** Cottin, R. (Elf Aquitaine, Pau (France)); Sahuquet, B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Following the oil price shocks of 1974 and 1979, European oil companies did their utmost to develop their technology in enhanced recovery (EOR). In this fashion, Elf Aquitaine group operated 16 pilots in seven years of which seven were thermal, five chemical, and four miscible. Despite the price drop in crude price since 1982, this effort is continuing. It is from the results obtained on these pilots that it is possible to present economical data on Elf Aquitaine EOR operations, emphasizing waht differentiates it from the American/experience. Microemulsion flooding, carbon dioxide injection and steam injection projects are discussed. At present, only the steam injection projects are showing a profit.

21209 (CONF-850710–, pp. 63-69) **Site selection for a heavy oil upgrader.** Wenzel, F. (VEBA OEL AG, Gelsenkirchen (West Germany)); Krauss, G.; Kamkoff, J.; Garcia, D.; Martinez, C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents a procedure for the selection of the most favorable site for a heavy oil upgrader. In this case a complex is considered consisting of the production field, the upgrading plant, the shipping terminal, and the necessary pipeline connections. This complex, with the variations of the different proposed sites, is the basis for the construction of the location model used in the study. Emphasis is given to the methodology which, by considering several cost factors that depend on the location, allows a quantitative comparison and therefore an optimized site selection on a least cost basis. The cost factors are organized into three major groups, and the relation between the upgrader and each individual factor is indicated. For the purpose of simplicity, the results calculated on

an annual cost basis are compared as differentials to the lowest cost alternative. This method has proved to be more advantageous than the more traditional qualitative ones because it reduces the possibility of bias judgement errors. In principle, the methodology is suitable for the site selection of any industrial complex.

21210 (CONF-850710–, pp. 161-169) **Heavy oils of India and the problems in their production.** Goyal, K.L. (Oil and Natural Gas Commission, Dehra Dun (India)); Pathak, A.K.; Datta, H.C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The estimated heavy oil reserves of the Western and Eastern Region fields of India are about 155 million tons, of which 5-10% are recoverable during primary flowing production and 20-30% of the remaining may be recovered by various suitable enhanced recovery techniques. The oils are less than 20° API, have viscosities of 15-60 cp, and are asphaltic or paraffinic in nature. Petrophysical properties of these reservoirs are moderate to good and their depth varies from 800 m to 2500 m. The paper describes the geology, occurrence, migration, and accumulation of these oils, the reservoirs, and the crude oil properties of the Western and Eastern Region fields of India. The technological and economic problems associated with heavy and medium-heavy crude production have been identified and are discussed in detail. Suitability of enhanced recovery techniques to realize the maximum production potential from these oil fields is reviewed.

21211 (CONF-850710–, pp. 337-342) **Application of bacteria to the in situ recovery of heavy oil.** Jack, T.R. (NOVA/Husky Research Corp., Ltd., Calgary, Alberta (Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Even in microbially enhanced oil recovery (MEOR) schemes, heavy oil presents a unique production challenge, and recently proposed criteria have generally excluded it as an MEOR target. Their findings support the generally accepted theory that anaerobic attack on crude oils is a very limited process and that heavy oil is less susceptible than conventional crudes to biological alteration. Supporting fermentation by injecting an organic substrate like molasses into the reservoir can support in situ bacterial activity. Thus the ultimate limits on the application of MEOR schemes may be the injectivity of essential nutrients as well as appropriate bacteria into the target formation. On this basis, selective plugging to control undesirable water flow in situ or to seal off channels or thief zones prior to thermal recovery operations remains an attractive possibility for heavy oil fields.

21212 (CONF-850710–, pp. 343-350) **A biotechnological alternative for recovering heavy oil.** Longkuan Jang (California State Univ., Long Beach (USA)); Tehfu Yen. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. DOE Contract AS19-81BC10508. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Currently heavy oils are primarily recovered by thermal methods (e.g., steam flooding and combustion heating) and complemented by other methods, including caustic, micellar, and polymer flooding. In recent years, the development in biotechnology offers an alternative approach of recovering petroleum. However, all the available literature on microbial enhanced oil recovery (MEOR) worldwide deals with light oil. The authors are among the first to experiment with success on heavy oil recovery by the application of MEOR. The authors initiated laboratory experiments for recovering heavy oil Ranger Zone, Long Beach, CA, (17°API) from simulated porous media (e.g., sandpack column and Berea sandstone core). An aerobic, Gram positive, surfactant-producing bacterium, Bacillus sp., was inoculated along with nutrient. The time course of oil production by the bio-huff-and-puff process developed in this work was recorded. They found that as high as 40% residual oil left after water flooding can be recovered. An anaerobic, Gram positive, gas- and solvent-producing bacterial strain Clostridium acetobutylicum was also used to recover oil from a low permeability (ca. 20 md) limestone core from a Kansas reservoir. They found that contrary to conventional criteria, low permeability is no longer a limiting factor for applying the microbial method to recover oil. Based on state-of-the-art development in MEOR, protocols for future work are suggested. The application of genetic engineering in improving bacterial functions is also forthcoming.

21213 (CONF-850710–, pp. 351-357) **Potential uses of microbes for continuous near-wellbore treatment during heavy oil production.** Savery, W.T. (Petrotec Systems, Inc., Denver, CO (USA)); Janshekar, H.; de Four, M.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

One method of effecting continuous treatment is via the creation of a cylindrical ring of microbes at or around the Lambda radius. The Lambda radius has been shown in prior publications to optimally vary between 16 and 60 feet. Thus, by combining innovative Microbially Enhanced Oil Recovery (MEOR) concepts with the Lambda technology or with several small diameter wells drilled from the surface within the Lambda radius, microbes can be emplaced in a desired configuration by sidewell to sidewell injection. Once the microbes are emplaced, acids, water-wetting agents, demulsifying compounds, and/or gases are generated and transported on a continual basis through the near-wellbore region, reducing the resistance to oil flow to a minimum. This paper will discuss, conceptually, the methodology for creating and emplacing the microbial ring as well as the potential of certain microbial species for application to this system.

21214 (CONF-850710–, pp. 359-371) **Biosurfactant production and laboratory application tests for heavy crude oil.** Olsen, D.K. (National Institute for Petroleum and Energy Research, Bartlesville, OK (USA)); Janshekar, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper describes the production and laboratory evaluation of the rhamnolipid PG-201, a biosurfactant, as the primary surfactant for use in chemical enhanced oil recovery (EOR) of light and heavy crude oil. Surfactant flooding has great potential for oil recovery. Application to some heavy crudes has been difficult due to the high viscosity of the crude and the high cost of surfactant. Biologically

produced surfactants, or biosurfactants such as PG-201, show considerable promise for lower cost and effective oil recovery as compared to commercial petroleum sulfonates. This paper summarizes the production of PG-201 from the bacterial strain Pseudomonas aeruginosa from both batch and continuous culture processes. Principal culture parameters for both processes have been investigated for optimal biosurfactant production. Ideal conditions for rhamnolipid production do not necessarily correspond to optimal conditions for bacterial growth nor is surfactant production directly proportional to the growth rate of the microbes. Analysis of PG-201 for application in EOR showed that the surfactant behaves as a water-soluble surfactant without exhibiting an optimal response to salinity. The biosurfactant showed a strong pH dependence and yielded low interfacial tensions against hexadecane. Oil recovery from corefloods using large pore volumes of 3% PG-201 gave the same recovery as equal pore volumes of water-soluble petroleum sulfonates. Recovery was not maintained at either lower concentrations or smaller slug sizes with light oil; however, with heavy crude the oil recovery was maintained at lower surfactant slug sizes.

21215 (CONF-850710–, pp. 413-419) **Effect of core preparation on laboratory steamflood results.** Wendel, D.J. (Petroleum Testing Service, Inc., Santa Fe Springs, CA (USA)); Swanson, G.S.; Kunkel, L.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents results of several laboratory steamflood comparative studies, with emphasis on preflood preparation steps. The influences of common initial core condition and resaturation techniques were evaluated by measuring S_{or} to steam and wettability. Fresh core samples yielded slightly lower S_{or} to steam values than those samples which had been weathered. The temperature of the samples during resaturation steps had no significant effect on S_{or} to steam in this study. The wettability of samples which had been extracted was changed from the original moderately oil-water condition to a slightly water-wet condition. Aging previously extracted samples restored initial oil-wet conditions.

21216 (CONF-850710–, pp. 433-439) **Influence of clays in steam injection projects.** Abud, J. (Petroleos de Venezuela, Caracas (Venezuela)); Dalence, G.; Kubacki, W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This work shows the importance of the mineral composition of clay in a sand reservoir and its effect on production. At the same time, possible solutions to the operational problems present in the exploitation of heavy crude associated with unconsolidated sands are established. For this purpose, active projects of S.A. MENEVEN in heavy and extra heavy crude reservoirs in the San Tome district were selected from Traditional Area and from Hamaca-Pao. Classical literature takes into consideration two important factors in the extraction of this type of crude: interfacial tension and viscosity. Recent investigations show that the presence of clays in formations directly affects the efficiency of well productivity. The study comprised two different phases of execution, each with specific limitations and perspectives, the first phase theoretical, the second experimental.

21217 (CONF-850710–, pp. 453-463) **Production of heavy crudes in presence of water.** Dalence, G.A. (MENEVEN, Anzoategui (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The present work shows the field results of a steam injection pilot project carried out in eastern Venezuela. The principal characteristic of this work is the presence of a water-oil contact in the basal sand, clearly identified by cores and electric logs run in the wells. The high oil recoveries obtained after 2 cycles of injection show the feasibility of the applied process, if it is considered that the production through natural depletion is not attractive due to the rapid inflow of water after short periods of production.

21218 (CONF-850710–, pp. 465-473) **Heavy oil recovery improvement.** Dismukes, N.B. (Dismukes and Co., Carrollton, TX (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Two distinct oil recovery improvement methods are combined in this new technology. A long horizontal well in the oil reservoir contributes its own increase. Then, this improved rate is further increased by application of the Continuous Heat Soak (CHS). The reservoir oil is heated by conduction, oil viscosity is reduced, and thermal expansion of the oil adds to the normal driving forces. A survey of the literature indicated a five-fold increase in oil production rate from a 305 m (1000 feet) horizontal well when compared with a vertical well in a 30.5 m (100 feet) thick sand. Wellbore heating would cause a three-fold increase in the horizontal well rate. The product of these two increases indicates a 15-fold increase in production rate (1500%).

21219 (CONF-850710–, pp. 475-481) **Steam quality measurements by neutron transmission.** Woiceshyn, G. (Petro-Canada Research, Calgary, Alberta (Canada)); Martin, W.; Montin, J.; Yuen, P.; Manzano, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Accurate measurements of steam quality at individual wellheads is required for the operation and evaluation of steam injection enhanced recovery projects. Over the past three years Atomic Energy of Canada, Petro-Canada, and INTEVEP have been developing a densitometer for field measurement of wellhead steam quality. This paper describes the meter principle and its construction and gives results of a calibration carried out at field flow rates and pressures. The design criteria applied in the development phase were that the meter should be nonintrusive, portable, easy to operate, and safe for field use, and should operate with high accuracy over a wide spectrum of harsh environmental conditions. An initial feasibility study showed that thermal neutron attenuation could give a direct measure of the average density or void fraction of wet steam. Development proceeded using this principle on the assumption that

steam quality could be derived from an appropriate slip correlation or by direct calibration at field conditions. The neutron beam is generated by a radioisotope source and collimator the strength of the transmitted neutron flux is measured by a detector and related to the density of the wet steam along the beam path. The field prototype instrument is arranged for clamp-on use near a wellhead. Calibration tests of the unit were carried out at the Sheridan Park Engineering Laboratory of Atomic Energy of Canada (AECL) in Mississauga, Ontario, Canada. The test conditions were 0-100% quality, 5-12 MPa, 1-3 kg/s in three-inch schedule 160 pipe for flow in both a horizontal and vertical arrangement. Further tests are planned at the Institute for Reactor Components, Kernforschungszentrum Karlsruhe, W. Germany for June 1985.

21220 (CONF-850710–, pp. 483-487) **Field results of steam diversion agents in cyclic steam applications.** Eson, R.L. (Petrotec Corco, Bakersfield, CA (USA)); Cooke, R.W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Steam injection was introduced as a process for the enhancement of recovery from heavy oil reservoirs nearly three decades ago. Now, steam stimulation and steam flood projects are responsible for approximately 80% of the enhanced oil recovery (EOR) production in the US. This growth has occurred despite the fact that the performance of the process has proven sensitive to factors such as reservoir heterogeneity, adverse mobility ratios, gravity override, and steam channeling, among others. Research into the development of specialized chemicals for use as steam diversion agents was initiated in 1973. This was an industry-wide effort with the goal of better utilizing the costly steam being injected for oil recovery by solving one of the major drawbacks of the process. The chemicals were intended to increase the resistance to flow in high permeability steam-swept channels thus diverting the steam to unswept regions and encouraging a more uniform steam distribution in the reservoir. This resistance to flow is often obtained by introduction of surfactants with the steam to generate a foam in the steam-swept channels. The presence of the foam then acts to reduce the mobility of the steam. This paper will discuss the field results from a sampling of over 4000 producing wells treated with foam diversion surfactant during cyclic steam stimulation over the past 11 years by Chemical Oil Recovery Company (CORCO). All treatments were performed in an effort to optimize sweep efficiency during steam injection into heavy oil reservoirs.

21221 (CONF-850710–, pp. 495-499) **Optimized cluster drilling in the Orinoco Heavy Oil Belt.** Gil, L.R. S.A. (MENEVEN, Bakersfield, CA (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

S.A. MENEVEN started drilling in the Orinoco Heavy Oil Belt in 1979. By July 1982, a total of 340 vertical wells were drilled and completed. As a consequence of this conventional drilling, thousands of acres of land were used for access roads, drilling sites, and construction of production facilities. This caused great damage to the ecology of the region. In the Hamaca-Pao oil fields, however, MENEVEN began using cluster drilling methods. The characteristics and properties of the fields (i.e., the existence of heavy and extra heavy oil at shallow depths, unconsolidated sands, etc.) facilitated the use of cluster drilling. As a result, having drilled nine clusters with some 50 wells in the Hamaca-Pao fields, and having constructed their associated production facilities, MENEVEN has gained a great deal of experience in the use of this technique. This paper discusses these experiences and the benefits achieved in using cluster drilling. Review of the MENEVEN cluster drilling program indicates that the resources needed to drill and bring the Hamaca-Pao fields into production have indeed been optimized. Significant savings in both time and money were achieved as a result of centralizing the drilling and completion activities in each of the nine cluster sites. More efficient use of production, steam injection, and crude handling facilities was also realized. In addition, the damage to the environment caused by conventional drilling practice was reduced, allowing more land to be available for agricultural development.

21222 (CONF-850710–, pp. 501-511) **The Jobo steamflood project case history.** Camacho, T.F.; McGee, J.H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper discusses the Jobo field steamflood pilot project conducted by LAGOVEN, S.A., Filial de Petroleos de Venezuela, S.A. This project is unique in the sense that it is conducted under high pressure (1300 psi) due to the presence of a strong natural water drive, which prevents pressure depletion by primary steam stimulated production. Several aspects under evaluation are discussed, such as well pattern and spacing, numerical simulation, well completions, surface facilities, and surveillance tools. Results to December 1984 are presented. The project has been very successful to date since oil recovery has exceeded anticipated values, and important knowledge has been gained that will serve for future commercial development planning. About 25% of the original oil-in-place has been produced over about half the pilot life; final recovery is estimated to be in excess of 40%.

21223 (CONF-850710–, pp. 523-533) **Orinoco oil belt experimental production blocks.** Machado, C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In 1978, Petroleos de Venezuela S.A. conceived a program to evaluate the Orinoco Oil Belt, an area of approximately 54,000 km^2 north of the Orinoco River. Petroleos de Venezuela S.A., as part of this program, assigned areas of exploratory responsibility to its four main operating companies: LAGOVEN S.A., CORPOVEN S.A., S.A. MENEVEN, and MARAVEN S.A. LAGOVEN S.A. was assigned an area of 1700 km^2 located in the south of Monagas and Anzoategui States. This area, also called Cerro Negro, contains approximately 214 billion barrels of original oil in place, ranging from 6° to 10°API gravity. In 1984, LAGOVEN S.A. started operating two experimental production blocks, the J-20 and 0-16 blocks, comprising 143 production wells, 4 observation wells, and all of the supporting gathering and production surface facilities. The objectives of these experimental blocks are to quantify cold flow and steam-stimulated well response, to identify reservoir producing mechanisms with special emphasis on compaction, and to develop a detailed evaluation of various types of well completions, surface and subsurface lifting equipment, as well as heat exchanging and fluid separation equipment. This paper presents a brief description of the experimental production blocks, followed by the geological aspects and the evaluations that will be carried out at these blocks.

The results obtained from these evaluations will provide the basis for a systematic and economical development of the Orinoco Oil Belt.

21224 (CONF-850710–, pp. 535-546) **Techniques for treating and dehydrating eastern Venezuelan heavy oil.** Munoz, R.C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Since 1976, LAGOVEN, S.A. has operated the southeastern Monagas fields in Venezuela. Current production is about 100,000 barrels a day of 8°-13°API heavy crude oil. Due to intensive production, associated formation water contents are as high as 70% of total fluid production. Treatment and dehydration of this heavy oil includes dilution with 35°API gas oil, heating, and chemical treatment. These 12°API oil-diluent blends are dehydrated to pipeline specifications (1% BS and W) at three major central stations by means of either electrostatic dehydrators or wash tanks. Due to the high viscosity of the blends (2,000 cst at 122°F), heat is required for an efficient dehydration process. Typical operating temperatures range from 180°F for atmospheric wash tanks to 240°F for pressurized electrostatic dehydrators. Chemical treatment is also essential for dehydrating heavy oil. Typical demulsifier concentrations are about 100 parts per million on clean oil volume. Oil produced by steam injection, however, requires concentrations as high as 300 parts per million. Field experience has demonstrated that wash tanks offer better operational flexibility than electrostatic dehydrators. The main advantage of wash tanks is basically better performance than electrostatic dehydrators for continuous changes in fluid flow rates and higher tolerance to suspended-solids concentrations and fluid density variations.

21225 (CONF-850710–, pp. 547-555) **Feasibility of a steamflood in a Lake Maracaibo Reservoir.** Carrasquel, A. (LAGOVEN, Maracaibo (Venezuela)); Romero, O. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents the results of a steamflood feasibility study recently completed for a LAGOVEN-operated heavy oil reservoir located in the Lake Maracaibo area of western Venezuela. The Lower Lagunillas-4 (LL-4) reservoir, of Miocene age, contains 2.1 billion barrels of original oil in place ranging from 14.5° to 23°API gravity. The heavy oil portion of this reservoir contains 422 million barrels of 14.5°API oil in place at an average depth of 2350 feet. The study employed numerical simulation to predict the heavy oil reservoir performance under natural depletion, pattern water flooding, cyclic steam injection, and steam flooding. The results show that infill drilling to 173 m spacing with inverted seven-spot patterns and a process based on the injection of two steam cycles followed by steam flooding, would increase recoverable reserves from 54.2 million barrels to 246 million barrels, and result in an ultimate recovery of 58% of the STOOIP. The conceptual design of the project contemplates cluster drilling of wells from a central platform, which would also contain production separation and steam generation facilities. As part of the study, the feasibility of laying and operating an insulated high pressure steam line in about 50 feet of water depth was evaluated, but additional testing will be required to complete a detailed design.

21226 (CONF-850710–, pp. 557-569) **LAGOVEN's slug flow gas lift of heavy oil production.** Jaimes, R. (LAGOVEN, Tia Juana (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents the results obtained from the development of the Slug Flow gas lift technique. This technique was developed in an effort to avoid many of the problems associated with either the continuous or the intermittent gas lifting of heavy, foamy crudes. The viscosity of heavy crudes increases substantially as it is produced up the tubing because of the cooling effect; additionally, if the crude-gas-lift gas contact creates stable foams, the viscosity of the lifted fluids further increases. Slug-flow gas lift reduces substantially the foam generation that results from the oil-gas mixing downhole.

21227 (CONF-850710–, pp. 571-580) **M-6 steam drive project steam/hot water production control.** Cerrada, R. (Maroven, Maracaibo (Venezuela)); Avila, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

MARAVEN has successfully been operating the M-6 steam drive project in the Bolivar coastal area of western Venezuela. The shallow and unconsolidated reservoir is being produced by some 134 pumping wells completed with gravel-packed open-hole liners over the entire hydrocarbon-bearing interval. Field observations, using downhole flowing, temperature, and pressure surveys through temporary dual well completions, revealed an unbalanced steam entry and subsequent oil production over the various subreservoirs present within the overall gravel packed completions. Preferential drainage could be correlated to those subreservoirs with the most favorable flow characteristics, i.e., high permeability/porosity values of the sands; this is considered to be the main reason for the steam/hot water breakthrough that has occurred so far in 25% of the production wells of the project. Because high steam/hot water production leads to a substantial reduction of oil production and high heat losses, methods have been developed to isolate the invaded sands by selective plugging of the gravel bed and recompletion, according to the requirements on a well-to-well basis. Until now a total of 36 wells have been selectively completed and a gain of 4,000 b/d of oil has been realized.

21228 (CONF-850710–, pp. 581-592) **Water treatment and steam generation system for enhanced oil recovery using production water.** Sanchez, J.C. (INTEVEP, Caracas (Venezeula)); Thielen, W.; Moricet, M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Commercial exploitation of the large heavy oil reserves in the Orinoco Oil Belt using steam stimulation will require vast quantities of water that will not always be available from natural resources in some areas. In order to assure enough water to cover the steam demand, and also reduce production-water treatment and disposal

requirements associated with the oil field development, a research program has been started to determine the feasibility of using production water for steam generation. Production waters from steam-stimulated oil fields consist of a mixture of condensed injection steam and naturally-occurring brine within the reservoir. The constituents of production waters that are potentially troublesome for adequate steam generator operation are hardness-related metals, Ca and Mg, suspended solids, oil, dissolved organic matter, and silica. These contaminants in such saline waters can cause serious scaling and corrosion problems, and even tube failures in steam generators. Thus, removal of these contaminants is necessary for the reuse of production water as steam feed water. The goal of this study is to determine the minimum feed water quality necessary to permit reliable once-through boiler operation without producing serious scaling and corrosion problems in the evaporator tubes, and to establish the suitable water treatment process to produce this minimum feed water quality. Results from steam generation and water treatment tests, carried out in laboratory test rigs, are presented in this paper.

21229 (CONF-850710–, pp. 593-597) **Wet oxidation downhole steam generator for recovery of deep heavy oil.** Clark, S.W. (Petrotec Systems, Inc., Denver, CO (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A recently patented downhole steam generator is expected to significantly enhance the recovery of heavy oil at depths below 610 m. The system employs wet oxidation, a flameless, nonpolluting process used industrially since the 1940s. Overall effectiveness of downhole wet oxidation in achieving heavy oil mobility is estimated to exceed that of surface steam generators by a factor of two or more. Appropriate target deposits of heavy oil comprise at least 110 billion barrels worldwide, including 13.3 billion barrels identified in fully engineered US reservoirs. Downhole wet oxidation operates at temperatures of about 260°-320°C and pressures of at least 60 atm; thermal efficiency of the process approaches 100%. The steam generator is constructed by reaming out a cavity below the pay zone, injecting a fuel ir slurry form, and bubbling oxygen or compressed air through the slurry. The slurry is typically a mixture of water and any one of several relatively cheap, water-wettable fuels such as coal, lignite, wood chips or sewage sludge. Heat from the process vaporizes water from the slurry; the resulting steam rises through the injection casing and infiltrates the pay zone. Petrotec Systems Inc. is currently designing a field test of its proprietary wet oxidation downhole steam generator.

21230 (CONF-850710–, pp. 599-606) **Production of heavy crude oil using downhole steam generators.** Fox, R.L. (Enhanced Energy Systems, Inc., Albuquerque, NM (USA)); Donaldson, A.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Thermal enhanced oil recovery operations using downhole steam generators have been carried out in a variety of field locations in California, Texas, and New Mexico. The downhole generators utilized in the projects discussed in this paper have all been of the direct contact design, which produce a combination of high pressure gases (CO_2 + N_2) with steam. Field operations have included steam drive using LPG or diesel fuel, steam drive and cyclic steam stimulation using natural gas, and cyclic steam stimulation using a variety of lease crude oils. Three of these operations are reviewed in this paper. The Wilmington field at Long Beach, California, has been stimulated by steam drive projects using downhole generation since 1981. The response of the reservoir to stimulation by steam with combustion gases is very promising. Steam stimulation projects with direct contact generators have been carried out on two wells at an existing conventional thermal recovery site in the San Joaquin Valley of California. Both of the wells stimulated with direct contact steam generation exhibited improved oil/steam ratios compared to previous stimulations using conventional steam. Several leases at the Taylor-Ina field in south Texas have had wells cyclically stimulated using downhole steam generators. Results from these stimulations have produced oil/steam ratios in the range of 0.75 to 0.85. Direct contact downhole steam generator systems are providing reliable service in the oil field environment with the potential for greater recovery rates than conventional methods.

21231 (CONF-850710–, pp. 615-622) **Electromagnetic stimulation of heavy-oil wells.** Bridges, J.E. (IIT Research Institute, Chicago, IL (USA)); Sresty, G.C.; Spencer, H.L.; Wattenbarger, R.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper describes an electromagnetic near-borehole heating concept that can be applied from a single borehole to enhance production rates from flowing wells. This concept is applicable to reservoirs in which fluid flow near the borehole is impeded by the high viscosity of oil or by precipitation of paraffin. An electromagnetic analytical heating model was developed and the resulting spatial distribution of heat was input to a reservoir model. Based on several example studies, a producing heavy-oil well could be electromagnetically stimulated to increase flow rates from 100% to 900%. Scale-model laboratory test confirmed heating patterns and stimulated flow rates. A series of pilot tests in very shallow reservoirs are producing design data to develop commercial versions of the electromagnetic (EM) stimulation process. The first pilot test, a stripper well version, has been under way for several months. The results confirm the analytical models and equipment designs and demonstrate substantial heating beyond the wellbore accompanied by the expected production rates. The process offers a very high energy efficiency and should permit, for many reservoirs, an incremental investment cost of $2,000 to $3,000 per daily barrel of incremental increased capacity. The operating costs are about $2 per barrel of oil produced.

21232 (CONF-850710–, pp. 623-636) **Lambda technology - A new approach to improved heavy oil recovery.** de Four, M.A. (Petrotec Systems, Inc., Denver, CO (USA)); Broz, J.S.; Savery, W.T. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A theoretical treatment is presented of the critical influence that near-wellbore conditions have on the recovery of viscous crude oils. Fundamental flow principles are applied in order to derive a stress-tensor description of the rate of energy dissipation for a viscous Newtonian fluid flowing radially through a porous medium. The resulting theoretical relationships verify that the naturally occurring logarithmic pressure distribution is responsible for the dominant influence the near-wellbore region has on oil production rates and ultimate oil recovery. Further theoretical analysis shows that an improved Optimal Spatial Pressure Distribution (OSPD) can

be created throughout a wells drainage area by altering the flow condition in the near-wellbore region. Moreover, it is proposed that this alteration can also result in increased oil producing rates and in improved ultimate oil recovery. A practical method for modifying the natural pressure distribution is proposed as via the creation and maintenance of one or more radial discontinuities of rock, rock/fluid, or fluid properties near the producing wellbore. These discontinuities can be most effectively created by chemical injection, heat, and/or pressure application through multiple slim-hole sidewells emanating from the main producing wellbore. This proposed technique is called the Lambda technology and key design criteria and equations for its application are presented.

21233 (CONF-850710–, pp. 637-641) **Cable lift technology for the recovery of heavy oil.** Lee, V. (Cable Lift 1,1Corp., San Jose, CA (USA)); Nunnally, J.; Irwin, R.; Ennis, M.R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The cable lift machine is an attempt to use a simple and workable engineering technique at an affordable cost for the recovery of heavy oil. Where applicable it should benefit the producer by increasing efficiency of wells currently in production and creating the opportunity to operate marginal or shut-in wells at an economic advantage to the producer. The cable lift machine should lower operating costs across the board: initial acquisition and set-up, maintenance and service, lifting, and meeting environmental constraints. The machine is a new approach to capturing the heavy oil resource.

21234 (CONF-850710–, pp. 643-647) **The VR-S subsurface pump.** Vadasz, A.F. (INTEVEP, Caracas (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The production of heavy crude usually requires the operator to inject steam into the formation in order to lower the viscosity of the fluids. Unfortunately, when attempting to pump a recently injected well, the steam can break out of the well fluids, causing a steam lock that has the same damaging effect as a gas lock. In order to solve problems with the subsurface pump associated with the production of heavy crudes, it was necessary to review the pump's basic operating principles. Once this analysis was completed, it was determined that major changes had to be made if the volumetric efficiency was to be improved. The VR-S subsurface pump described in this paper accomplishes this objective.

21235 (CONF-850710–, pp. 649-659) **Offshore California heavy crude: Potential and production.** Jennings, E.E. (Dept. of the Interior, Los Angeles, CA (USA)); Alonzo, C.J.; Mitchell, M.E. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Offshore, California's potential for the production of heavy crude oil (API < 20°) is linked with the development of the Miocene age Monterey formation. Most proven heavy oil reserves in the Pacific Outer Continental Shelf (OCS) region are associated with this highly fractured, fine grained, siliceous and calcareous formation. Although heavy oil is being produced in several sandstones (Sespe, Hueneme, Puente), future developments in California's Santa Maria Basin and Santa Barbara Channel focus on Miocene Monterey pay. The number of offshore oil platforms in California is expected to nearly double by the year 2000. Production will come from 25 to 30 platforms and will increase from 84,000 b/d to 200,000-500,000 b/d. Approximately 70% of this maximum production level could be heavy crude coming from the Monterey. Current estimates show known recoverable reserves of nearly one billion barrels of heavy crude. Improved production methods, advanced platform design, and oil price escalation could substantially increase these estimates. Logistics and processing are major problems in the development of heavy crude. California's refining capability for heavy crude is limited. Producers must decide whether to retrofit existing California refineries or transport the oil to Gulf Coast refineries by pipelines or tankers. In any case, substantial investment and lengthy permitting would be involved. Another option would be for producers to build a facility to upgrade the heavy crude oil to allow its processing through West Coast refineries without retrofitting. This would also require a substantial investment by the operators and involve a difficult permitting process.

21236 (CONF-850710–, pp. 661-667) **Offshore production and transportation of heavy oil.** Visser, R.C. (Belmar Engineering and Management Services Co., Redondo Beach, CA (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper presents both methods and actual experiences with the production and transportation of low gravity, high viscosity crude from offshore fields. The paper addresses methods available for lifting and treating low gravity crude on an offshore platform and discusses advantages and disadvantages. Methods used and/or considered for pipeline transportation of low gravity crude to shore are discussed. The paper also reviews actual experiences with heavy oil production and transportation offshore southern California as well as current plans for development of newly discovered heavy oilfields in the Santa Maria basin offshore central California and offshore Sicily in the Mediterranean.

21237 (CONF-850710–, pp. 837-845) **Results from a preliminary feasibility study of electromagnetic hot water flooding for tar sands and heavy oil.** Broz, J.S. (Petrotec Systems Inc., Denver, CO (USA)); Savery, W.T.; Bridges, J.E.; Sresty, G.C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Preliminary engineering and cost-estimate analyses have been conducted for an electromagnetic in situ heating and hot water flooding process designed specifically for the in situ recovery of deep tar sand and heavy oil resources. A site-specific economic feasibility analyses for the process applied to a deep (600 m) Alberta tar sand deposit demonstrated the probable economic viability of this new technology under current oil-price assumptions. An after-tax internal rate of return of 64% was calculated for a base forecast case using conservative assumptions for oil prices, production rate, capital equipment costs, operational costs, and tax regulations. Sensitivity analyses showed the after-tax investment

return ranging from a lowest value of 40% to over 100% with regard to key operating and production variables. Operating expenses averaged $7.50/bbl, while the capital requirement for turn-key technology implementation was estimated to be $3500 per installed daily barrel of project capacity.

21238 (CONF-850710–, pp. 863-873) **Investigation of wet oxidation for bitumen and heavy oil recovery operations.** Robey, H.L. (Ontario Research Foundation, Mississauga (Canada)); Faurschou, D.K. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

An extensive research program was undertaken to assess the technical and economic feasibility of using wet air oxidation, specifically the Wetox process, in oil sands recovery operations. A previous paper study by CH2M Hill Canada Ltd. (CH2M Hill, 1982) concluded that wet oxidation could be competitive with conventional steam generators under certain circumstances. A variety of high sulfur, low-grade solid fuels, as well as steam stimulation produced waters from the Athabasca and Cold Lake deposits in Alberta, Canada, were tested (Robey, 1985).

21239 (CONF-850710–, pp. 875-889) **A method for treating recalcitrant oil-in-water emulsions from steam-stimulated bituminous deposits.** Chakrabarty, T. (Esso Resources Canada Ltd., Calgary, Alberta (Canada)); Thomas, R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Recalcitrant oil-in-water emulsions are occasionally produced during cyclic steam stimulation of a deep bituminous deposit. These emulsions cannot be broken by conventional organic or inorganic oilfield demulsifiers and hence may cause upsets in the plant for recycling produced water to steam generator. In this paper, a method is described to break the recalcitrant emulsions using small amounts of sodium montmorillonite in conjunction with a conventional demulsifier. The results of laboratory tests using emulsions from Esso Resources Cold Lake pilot as well as emulsions prepared in the laboratory are presented. The role of sodium montmorillonite in treating oil-in-water emulsions is discussed. A scheme of incorporating the method into an existing water reuse plant is outlined.

21240 (CONF-850710–, pp. 963-978) **The heavy oil/tar mat in the Prudhoe Bay Field, Alaska - Characterization and impacts on reservoir performance.** Haldorsen, H.H. (Sohio Petroleum Co., California (USA)); Mayson, H.J.; Howarth, S.M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Prudhoe Bay field, located at the north coast of Alaska, is the largest and most prolific of US oilfields. The field contains an areally extensive and variable thickness heavy oil/tar zone (HOT) present just above the oil-water contact. The HOT zone thus underlies the light oil column in most areas of the field, and to establish optimum development, depletion, and operating plans for the field, it was crucial to understand the mode of occurrence, the characteristics, and the transport properties of the HOT zone. The overall goal that indicated this work was to determine possible HOT recovery, and to assess the impacts of the HOT zone on reservoir performance. A variety of data sources, such as well tests, repeat formation tester (RFT) measurements, log interpretation and core analysis were utilized in the study. Log interpretation techniques were used on several wells across the field to show that the hydrocarbons in the HOT zone are relatively immobile, but that those hydrocarbons do not totally restrict the flow of water in or through the HOT. Methods used include the analysis of flushed zone resistivity data and PNL Log-Inject-Log tests with saline water. Estimates were then made to determine the effective permeability to water through the HOT interval. These include approaches utilizing an analytical formulation that relates the effective permeability to the observed range of RFT-derived pressure differentials across the HOT. Interpretation of RFT pretest data was also undertaken to provide small scale data of a more qualitative nature. In addition, a numerical analysis of field data and pressure fall-off analysis were used to determine effective permeability in the HOT zone. The computed values from the different methods were in good agreement, with an average effective permeability to water of approximately 1 md.

21241 (CONF-850710–, pp. 979-987) **Relationship of wettability to the Archie saturation exponent.** Donaldson, E.C. (Univ. of Oklahoma, Norman (USA)); Bizerra, M.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The interpretation of resistivity well logs relies on parameter, n, known as the Archie saturation exponent, $Sw = (F \times Rw/Rt)^{1/n}$, which is equal to 2.0 for clean, consolidated, water-wet sandstones. The saturation exponent, however, has been shown to range from 1.5 to as high as 25.0, due principally to the degree of wetting of the rock surface by oil. Use of an incorrect value for the saturation exponent can thus lead to errors of serious magnitude in the calculation of brine solution. The tendency of crude oils to wet rock surfaces has been correlated to the amounts and types of polar organic compounds in the crude oil, and a trend to greater oil-wetting tendency as the API gravity decrease was observed. Thus, a relationship between the saturation exponent and wettability is required for well-log interpretation, especially for the heavier oils. A quantitative method for wettability measurement, using centrifuge-derived capillary pressure, was used to develop a relationship between wettability and the saturation exponent for crude oils ranging in API gravity from 40° to 10°. The electrical resistivity index (Rt/Ro) is related to the brine saturation by: $\log I = -n \log Sw$, where n is the slope. This relationship is used to show the variation of electrical resistivity for oils having different wetting properties. This research shows that the correct value of n for well-log interpretation can be obtained by measurement of the wettability, using the centrifuge method.

21242 (CONF-850710–, pp. 989-996) **A discussion on the mechanism of foam flow through porous media.** Best, D.A. (Alberta Oil Sands Technology and Research Authority, Calgary (Canada)); Tam, E.S.; Isaacs, E. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude*

and tar sands. Order Number DE90005488. Available from NTIS, PC A99/MF A01.

An extensive review of the literature for foam flow through porous media reveals conflicting interpretations of the effects of process variables on performance. With this lack of mechanistic understanding, field-scale predictions of foam performance for mobility control are not yet possible. Their analyses have identified that major process variables K_{abs}, velocity, saturation, surfactant concentration, and interfacial tension can be correlated using K_{eff} as a function of capillary number and saturation. This multivariant correlation of K_{eff} has been used in a numerical thermal simulator to match laboratory foam flood experiments.

21243 (CONF-850710–, pp. 997-1007) **Simulation of steam injection through horizontal wellbores for viscous oil recovery.** Gussis, G.L. (Arco Resources Technology, Plano, TX (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Cyclic steam injection and steam drive from 2000-foot (610 m) horizontal wells were numerically simulated and evaluated for viscous oil recovery. Sensitivity studies included consideration of reservoir properties, such as relative permeability and layer stratification. Simulated and idealized well patterns included a continuous parallel well configuration, a spoke configuration with horizontal wells separated by 45°, and a staggered configuration with parallel horizontal wells at different depths. Nonparallel configurations and near-horizontal wells with vertical deviations were studied to assess process sensitivity to more realistic well alignments. Continuous parallel was the most promising configuration. Simulated oil recovery was 60% of the oil in place for the most favorable scenario, but was extremely sensitive to the extent to which wellbores were parallel and horizontal.

21244 (CONF-850710–, pp. 1009-1016) **The equivalence of a high velocity gas drive preceded by reservoir heating to a steam drive.** Doscher, T.S. (The Doschers Group, Inc., Ventura, CA (USA)); Hosseinmardi, K.; Baghdikian, S. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Earlier studies of the steam drive process led to the hypothesis that the performance of a steam drive could be duplicated by any kind of reservoir preheating followed by a high velocity noncondensible gas drive. This hypothesis has now been confirmed by bench scale, nonphysically scaled experiments. Despite the inherent limitations of such laboratory experiments, the results point to the potential of a new powerful enhanced oil recovery process for both viscous and high gravity crudes.

21245 (CONF-850710–, pp. 1017-1022) **Oilfield steam distribution, investigation of steam/water two-phase flow problems.** Manzano-Ruiz, J.J. (INTEVEP, S.A., Caracas (Venezuela)); Grases, P.; Kastner, W.; Kefer, V.; Koehler, W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

To fulfill the needs of the Venezuela oil industry concerning steam distribution in the steam drive and steam soak processes, a research program was sponsored to simulate actual two-phase flow in a single and parallel transmission lines and fitting was conducted. It was found that many mathematical models poorly predict the high pressure steam water flow data because they were developed under different conditions for different fluids. The homogeneous flow model provides good estimates for small diameter horizontal tubing (less than 50 mm) although with scatter on the order of plus or minus 30%. An adquate data bank is required to test two-phase pressure drop correlations under field operational conditions. A field scale test rig was designed to check full scale metering devices and to study two-phase flow phenomena at 1:1 scale.

21246 (CONF-850710–, pp. 1033-1041) **Blocking of high permeability zones in steam flooding by emulsions.** Broz, J.S. (Petrotec Systems, Denver, CO (USA)); French, T.R.; Carroll, H.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

It is well known that the economics of many steamflood enhanced oil recovery (EOR) technologies are strongly affected by steam override (gravity segregation) and steam channeling. The economic performance of many steamfloods can be improved if an effective method of plugging the steam override or channeling zones is utilized. Traditionally, foam blocking techniques have been utilized with variable success to achieve these goals. In this paper, the first phase of laboratory results in the development of a new emulsion blocking technique for the correction and control of steam override and channeling are presented. Coreflood experiments were performed to demonstrate the effectiveness of emulsion blocking at temperatures ranging from ambient to 160°C. The permeability reduction of various types of cores using externally produced emulsions and in situ generated emulsions was measured for light and heavy crude oils. Externally produced emulsions injected into oil-free cores reduced the permeability by 86% at 110° and 77% at 160°c. Emulsions generated in situ using a caustic emulsifier with Wilmington crude oil achieved a 43% reduction in effective permeability with the absolute permeability of this core 1400 md. In both cases of injected and in situ emulsions, the emulsion block was thermally stable and no time-degradation of the block was observed. The strong possibility that foamblocks as heretofore applied may have an emulsion blocking component to the overall plugging mechanism is discussed. Foams created with known foaming agents were contacted with various crude oils and the authors observed emulsified droplets within the liquid interfaces. Future work leading to the development of a field-pilot test and ultimate commercialization of the process is outlined.

21247 (CONF-850710–, pp. 1043-1049) **Laboratory response of medium and heavy crudes to thermal oil recovery.** Welch, W.P. (Texas A and M Univ., College Station (USA)); Crawford, P.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Many of the oil producing states of the US have heavy crude oil deposits from which little or no primary oil recovery can be expected. Much of the heavy oil is in thin, shallow reservoirs. For the

US, the heavy oil resources represent oils of 10° to 20°API gravity. The term resources is used since an economic oil recovery method having nationwide application has not been described. Thermal oil recovery methods customarily involve either in situ combustion, or the injection of hot fluids, usually steam. The midcontinent area and much of the world is known to have many shallow, thin oil reservoirs containing heavy oil or tar sands. Pilot thermal recovery projects have been described for reservoirs in Texas, Oklahoma, Louisiana, Kansas, Missouri, Illinois, Wyoming, Kentucky, Utah, and California. Although many thermal pilots have been initiated in the US midcontinent area, very few projects have been expanded. The projects have not been enlarged because they have not been profitable. In the case of steam injection, the oil sands are usually too thin to be of commercial value. The oil recovery cost is too great. In the case of in situ combustion the fire usually goes out, and the process reduces to an air drive, which is of little value in a heavy oil reservoir. The process studied in the laboratory used both steam injection and in situ combustion. The laboratory oil recovery results are presented for heavy oil. The results were good. Preliminary economic studies indicate that the combined process may produce heavy oil economically for some reservoirs in which either steam injection or in situ combustion alone would not be profitable.

21248 (CONF-850710–, pp. 1057-1071) **Laboratory simulation of thermal changes in heavy crudes during thermal recovery.** Monin, J.C. (Institute Francais du Petrole, Rueil-Malmaison (France)); Audibert, A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Both the matrix and the oil can undergo chemical reactions during high temperature and high pressure steam injection. For example, matrix decomposition observed when steam is injected into carbonate reservoirs can affect the permeability of the matrix. Several authors have recently reported on the carbonate transformations taking place during thermal recovery, especially the modifications in permeability and porosity of the rock matrix. The production of large amounts of CO_2 can lead to the formation of a secondary gas cap; if the pressure is high enough, CO_2 dissolution can have favorable effects on oil properties (swelling, viscosity decrease). On the other hand, high H_2s and CO_2 contents in the produced gas may cause severe corrosion damage in the surface equipment. The present work puts emphasis on the effect of the presence of minerals on oil alteration. The possible catalytic effect of the metallic walls of the cell is discussed and the influence of sedimentary rocks, such as carbonates (calcite, dolomite) or clays (illite), is evaluated. The combined effect of the heating time and the temperature on crude oil alteration is also examined, using different sets of operating conditions.

21249 (CONF-850710–, pp. 1083-1091) **Current technology of heavy oil recovery by immiscible carbon dioxide and water flooding.** Rojas, G. (Universidad de Oriente, Puerto La Cruz (Venezuela)); Farouq Ali, S.M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Two-thirds of the heavy oil deposits of the world cannot be exploited by means of thermal recovery methods, because the energy balance of a field project can be poor for reasons of reservoir depth and thickness, low oil saturation, or porosity. This huge amount of oil has provided strong motivation for the development of new and improved heavy oil recovery methods. One of the more promising of these techniques uses carbon dioxide and water for immiscible displacement of conventional, not-too-viscous, heavy oils (below 1000 mPa.s at reservoir conditions), as has been recently demonstrated by the excellent results of several field projects in the USA. This paper discusses the main recovery mechanisms of the process, presents the results of field projects showing their favorable and unfavorable aspects, and also describes a scaled model, which is being used to study the application of the process to the heavy oil reservoirs of Saskatchewan, Canada. The oil recovery by this process is found to be as high as 48% of the oil-in-place, and is shown to depend strongly on the water-carbon dioxide strategy used.

21250 (CONF-850710–, pp. 1093-1102) **Evaluation of CO_2 injection for heavy oil recovery.** Murtada, H. (VEBA OEL AG, Gelsenkirchen (West Germany)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Steam injection has been a viable technique for heavy oil recovery for almost 4 decades. The problems of poor areal and vertical sweep efficiency have, however, limited the recovery in many heavy oil reservoirs. It is believed that the overall recovery with steam (e.g., in steam drive or steam-soak projects) can be improved, if EOR agents are added to steam. This paper documents efforts to improve heavy oil recovery by injecting CO_2 with steam. The laboratory results reported are part of an R and D study designed to investigate the benefits of using CO_2 in a steam-based process for obtaining additional recovery from a 9°API heavy oil reservoir. Based on the laboratory results obtained so far it appears that CO_2 has potential not only to increase the oil recovery, but also to accelerate this, as compared to baseline flooding with steam only. Main parameters influencing the recovery from the above mentioned heavy oil are, among others, oil quality, oil saturation, blow down, reaction time (between oil/CO_2), and flood velocity. Improved and accelerated recovery results also from a uniform distribution of heat across the productive interval when CO_2 is injected with steam as compared to injection of steam alone.

21251 (CONF-850710–, pp. 1105-1121) **Grassroot upgrading complex for processing Orinoco heavy crude.** Wenzel, F. (VEBA OEL, Gelsenkirchen (West Germany)); Hallensleben, J.; Kamkoff, J.; Garcia, D.; Martinez, C.; Souto, A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The objective of this paper is to demonstrate the feasibility of a hydrogen addition process for the upgrading of heavy crude oils from the Orinoco Belt. Based on the results from bench-scale tests, performed for three heavy crudes by applying the VEBA-Combi-Cracking (VCC) and the Donor Solvent Hydrovisbreaking (DSV) processes, one of the above-mentioned technologies was selected for the prebasic design of a grassroots upgrading complex within defined battery limits. For the selected process, 15 alternative process schemes were developed comparing various conversion levels, hydrogen generation modes, etc., in an effort to optimize the upgrading concept.

21252 (CONF-850710–, pp. 1131-1139) **Staged heavy crude upgrading.** McCann, T.J. (RTM Engineering Ltd., Calgary, Alberta

(Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Conventional wisdom talks of large world-scale facilities, but heavy crude oil fields start small. The build up in production capacity is rate-controlled by the drilling of the many wells needed. Hence, a five- to ten-year program of field development is the norm. Previous papers have noted a lack of significant scale advantage in one time mega sized projects compared to smaller facilities. New staged approaches are definitely needed in heavy oil upgrading and refining. This paper reviews guidelines for stage process selection and discusses approaches to optimize the overall development in a developing country context. Two advantages stand out compared to single stage development - all work is done at an established plant site except for the first stage, and all increments are of an easily managed size and nature. The challenges of integration of staged upgrading with existing conventional refining facilities are specifically addressed for a hydroskimming example.

21253 (CONF-850710–, pp. 1141-1146) **Small scale upgraders integrated with field production facilities.** Shannon, R.H. (R.H. Shannon and Associates, Ltd., Islington, Ontario (Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Department of Energy, Mines and Resources of the Government of Canada contracted with R.H. Shannon and Associates Ltd., to undertake a technical and economic assessment of small scale hydrogen-addition upgraders utilizing Cold Lake and Lloydminster heavy hydrocarbon production facilities. The study was financed additionally by the Province of Alberta, through the Alberta Oil Sands Technology and Research Authority, and Norcen Energy Resources Limited. The study evaluated small scale integrated upgraders on a scale of 6,000 to 20,000 barrels per day at Lloydminster and Cold Lake, respectively. Small scale hydrogen-addition upgraders, due to the high volume of synthetic crude, shop fabrication, and shorter time to start up, are less capital intensive than very large coking projects. Innovations were made for phased processing by the installation of the hydrogen-addition upgrader, with a minimum of facilities for initial first phase operations, provided the unconverted residual fraction can be sold. The system is applicable to other sites.

21254 (CONF-850710–, pp. 1147-1157) **Noncatalytic heavy crude upgrading.** Elliott, J.D. (Foster Wheeler USA Corp., Livingston, NJ (USA)); Godino, R.L.; McGrath, M.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The two major noncatalytic processing routes for upgrading heavy residuum are solvent deasphalting and delayed coking. Foster Wheeler has a proprietary position in each of these two processes and offers the technology under the service marks LEDA (Low Energy Deasphalting) and SYDEC (Selective Yield Delayed Coking). These two technologies may also be integrated into a synergistic technology, which is offered by Foster Wheeler under the service mark ASCOT (Asphalt Coking Technology). ASCOT achieves high liquid product yields and beneficial process economics. By-product fuel grade asphalt and petroleum coke can be utilized effectively. However, the selection of specialized handling, combustion, and boiler technology must be matched to the fuel's characteristics.

21255 (CONF-850710–, pp. 1159-1165) **Technology available for residue upgrading.** Biasca, F.E. (SFA Pacific, Inc., Mountain View, CA (USA)); Schulman, B.L.; Dickenson, R.L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The analysis presented discussed several mature commercial technologies that are available to handle extremely heavy crudes. Further, many new technologies and catalysts which are in the advanced developmental and early commercial stages show economic advantages over the currently available processes, assuming critical technical aspects can be confirmed. This paper addresses some of the nonproprietary aspects of that analysis along with some of the general conclusions from SFA Pacific activities.

21256 (CONF-850710–, pp. 1167-1176) **Potential for asphaltenic bottom cracking technology in upgrading ultra-heavy oil.** Komatsu, S. (Chiyoda Chemical Engineering and Construction Co., Ltd., Yokohama (Japan)); Kashiwara, H.; Shimizu, S.I.; Suzuki, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Extensive commercial experience has been obtained in the use of ABC catalyst for processing high-metal and high-asphaltene residues in residue HDS units in Japan. Experience in the test-processing of Orinoco residue also has been gained. The VisABC process, based on the excellent performance of the ABC catalyst in high-temperature operation, is expected to provide the maximum attainable residue conversion of heavy residues in a fixed catalyst bed coupled with favorable product quality. Changes in content of both maltenes and asphaltenes explain how high conversion is achieved by the VisABC process. An economic study of refineries processing 100,000 BPCD of Orinoco or Arabian heavy crude shows that Orinoco can be upgraded at a refining cost greater than that of Arabian Heavy for the same products slate. From this, it is firmly believed that the application of the VisABC process to the upgrading of residues, including Orinoco, will gain practical importance in the near future.

21257 (CONF-850710–, pp. 1177-1185) **Advances in heavy oil processing.** Viens, C.H. (Lummus Crest Inc., Bloomfield, NJ (USA)); Fornoff, L.L.; Frith, J.F.S. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The upgrading of heavy oils and residues has been the subject of much research and development in recent years. The high cost of commercial systems for upgrading has been a restriction in the development of these vast resources of energy. This paper gives the results of studies by the Lummus Crest company in the development of lower cost approaches to heavy oil upgrading than obtained with other processes. This paper discusses three lower-cost adaptations of available technology to heavy oil upgrading: a new low-pressure hydrogen recovery scheme for the LC-Fining^{SM} process, which significantly lowers the plant investment cost; low pressure deasphalting process, that can be retrofitted to an existing crude unit; and low pressure delayed coking.

21258 (CONF-850710–, pp. 1187-1198) **LR-coking of asphaltenes.** Herbertz, H.A. (Petroleos de Venezuela, S.A., Caracas (Venezuela)); Solari, R.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In recent years solvent deasphalting has developed in the direction of increasing deasphalted oil yields, producing very high softening point asphaltenes of rather low commercial value. The authors describe a process for continuous coking of these asphaltenes to convert them into valuable liquid hydrocarbon products (yield 50%) and coke. The process combines the new INTEVEP deep deasphalting process with Lurgi-Ruhrgas coking technology already commercially proven with other feedstocks. Experimental results from pilot plant tests of Jobo heavy oil deasphalting, coking, and hydrotreating of coker distillates are extensively discussed. Based on these results, an engineering design of a 100,000 BPD upgrading complex using the solvent deasphalting plus LR-coking concept was completed, to economically evaluate different process schemes for the upgrading complex and to compare it to a conventional delayed coking upgrading system. The SDA-LR-Coking upgrading route is economically attractive and competitive with other upgrading processes.

21259 (CONF-850710–, pp. 1213-1217) **The Gulf Canada donor refined bitumen (DRB) process.** Logan, A. (Gulf Canada Ltd., Sheridan Park, Ontario (Canada)); Simpson, P.L.; Souhrada, F.; Woods, H.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Gulf Canada Donor Refined Bitumen Process upgrades heavy oils, bitumens, or conventional petroleum residua. A blend of vacuum residuum (550°C+) and a refinery-derived hydrogen donor stream, which contains a high proportion of substituted tetralins, is thermally cracked at low pressure in the liquid phase. The middle distillate fraction of the reactor product, containing the donors, now depleted in hydrogen, is reactivated by conventional catalytic fixed-bed hydrotreating and recycled to the reactor. The naphtha and gas oil fractions are similarly hydrotreated to high quality petroleum products. The hydrogen consumption is low and the process can be self-sufficient in donor. The process results in high liquid yields of good quality products from a wide variety of crude residua and is independent of the contaminating metals content of the feed. A detailed description of the process together with flowsheet, is given. Product quality and economic data are provided. The combination of DRB with solvent deasphalting of DRB pitch is economically attractive for some applications. Details of this combination process option, including the different schemes for handling the deasphalted oil, are discussed.

21260 (CONF-850710–, pp. 1219-1230) **Upgrading and enhanced recovery of tar sand bitumen and heavy crude using the ART process.** Geren, P.M. (Engelhard Corp., Edison, NJ (USA)); Center, A.M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Bitumen and heavy crude recovered from heavy hydrocarbon deposits are often too viscous to pipeline economically and too contaminated for conventional processing. The high viscosity and metal, sulfur, and nitrogen contamination encountered limit the usefulness and value of the hydrocarbon resource. The ART process, installed in a producing field, can both upgrade the hydrocarbon at high liquid yields to lighter, less viscous, less contaminated synthetic crude and provide steam for use in recovery. The process operates by selectively vaporizing the nonasphaltic fraction of the hydrocarbons while converting the asphaltic portion partly to lighter hydrocarbon products and coke. Substantial metal, sulfur, and nitrogen removals take place. Internal combustion of the coke provides energy to satisfy the process heat requirements plus high pressure steam, which can be used both for supplying mechanical energy and for separation of the heavy hydrocarbons from the deposits mineral matrix.

21261 (CONF-850710–, pp. 1231-1238) **High conversion upgrading of extra-heavy oils by a new process combination.** Washimi, K. (Toyo Engineering Corp., Tokyo (Japan)); Nelson, S.; Limmer, H.; Schutter, H.; Wada, T. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Toyo Engineering Corp. (TEC), Japan, and Kerr-McGee Corp (KM) recently developed a new process combing TEC's High Conversion Soaker Cracker (HSC) and KM's Residuum Oil Supercritical Extraction (ROSE) process. The HSC thermal-cracker distillates and the deasphalted oil recovered by the ROSE process from HSC resid have been successfully hydotreated by a low-pressure hydrotreater developed by VEB Petrolchemisches Kombinat (PCK), Schwedt, GDR. The basic concept of the process combination is that, by first thermally cracking the heavy oils at a severity between that of visbreaking and coking, the heavy metals are concentrated in condensed asphaltenes in the cracked resid. Concentrating the metals in the asphaltenes allows selective recovery of low-metal asphaltene-free nondistillable oil by solvent fractionation of the of HSC resid.

21262 (CONF-850710–, pp. 1239-1256) **HDH process for heavy crude upgrading.** Cavicchioli, I. (INTEVEP, S.A., Caracas (Venezuela)); de Drago, G.; Gonzalez, G.; Krasuk, J.; Larrauri, J.; Marzin, R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for*

Training and Research/United Nations Development Program] international conference on heavy crude and tar sands. Order Number DE90005488. Available from NTIS, PC A99/MF A01.

INTEVEP has been developing the HDH process to convert the crudes of the Orinoco Oil Belt (OOB) into a synthetic crude, whose fractions can be fed to conventional refining processes. This work has been undertaken due to the problem of processing crudes from the OOB because of their high contents of metals, sulfur and residue, the magnitude of the reserves, and the necessity of a suitable technology. The HDH process consists of: hydrocracking (H) of the atmospheric or vacuum residue in a bubble reactor under moderate temperature and pressure conditions, using a low-cost natural catalyst, abundant in the country; vacuum distillation (D) of the hydrocracked product; further hydrotreatment (H) of the fractions using conventional technology. The study of the different processing schemes of the hydrocracking stage reveals that those with recycling are favored for their greater synthetic crude yield and lower hydrogen consumption. The scheme without further hydrotreatment produces a stable synthetic crude of 23°API, sulfur 2.3%, without metals or residue, and with a yield of 96.6 v% from a typical crude of the OOB (8.2°API, sulfur 4.1%, and vanadium 500 ppm). The quality of the synthetic crude is improved when further hydrotreatment is included (30°API, sulfur < 0.1%, and with a yield of 99 v%). An economic evaluation favors schemes including recycling, without further hydrotreatment. Schemes which do not contemplate further hydrotreatment also offer strategic advantages, such as less investment and the possibility of using idle hydrotreatment capacity, thus facilitating the marketing of the synthetic crude. The schemes based on the HDH process present, at this stage of development, adequate differential profitability compared with the industrially proven technology of delayed coking. This may justify projects to implement an HDH commercial demonstration.

21263 (CONF-850710–, pp. 1257-1262) **Upgrading of bitumen by hydropyrolysis - A process for low coke and high syncrude yields.** Bunger, J.W. (Univ. of Utah, Salt Lake City (USA)); Oblad, A.G. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Hydropyrolysis represents one of several approaches to thermal hydrocracking of bitumen to produce distillate. Hydropyrolysis has been shown to convert virgin tar and bitumen in 99%+ yields to gaseous and liquid products at short (< 20 sec) residence times. The chemistry of hydropyrolysis is generally understood and points toward a process that maximizes vapor phase reactions. A 2 L/hour semicontinuous unit has been designed and constructed and is currently being operated. Results show that, with moderate severity, low amounts of gas and coke are produced and the heavy liquid is amenable to recycle to improve the overall conversion. Preliminary economics analysis has shown that there is no major factor, which would clearly render hydropyrolysis uneconomical.

21264 (CONF-850710–, pp. 1263-1272) **Deep conversion of heavy oil and bitumen via VEBA-Combi-Cracking - An update.** Lischer, H. (VEBA OEL AG, Gelsenkirchun (West Germany)); Kretschmar, K.; Niemann, K.; Cotte, E.; Guitian, J.; Marruffo, F. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Since 1978, more than 20 different feedstocks have been tested in bench scale units and the test results show that there are differences in the crackability of different crudes, which are more significant for pretreated materials such as visbreaker bottoms. On the basis of experimental results a process model was developed, on a statistical basis, which allows prediction of product slates and properties, together with hydrogen consumption, for the LQ- or Combi-Cracking of virgin residues. The bench scale experiments in total show that conversion levels of up to 98% can be achieved for all types of feedstocks at temperatures between 440° and 480°C and pressures from 150 to 300 bar. The required pressure level varies with feedstock quality. All results gathered from bench scale equipment are presently checked on a larger scale. For this purpose, VEBA OEL AG, INTEVEP S.A., and Lurgi GmbH, are running a 200 bbl/d VCC demonstration plant at the Ruhroel refinery, Gelsenkirchen.

21265 (CONF-850710–, pp. 1273-1280) **Mild resid hydrocracking for middle distillates: A new heavy oil upgrading alternative.** Armstrong, R.B. (M.W. Kellog Co., Houston, TX (USA)); Sadhukhan, P.; Sue, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Idemitsu Kosan Company, Limited and The M.W. Kellogg Company have developed a new process called Mild Resid Hydrocracking (MRH). MRH produces distillate products, including diesel-range fuel, directly from heavy oil such as vacuum resid or tar sand extracts. MRH employs a suspended-bed slurry reactor at lower hydrogen pressure than other hydrogenative upgrading processes. The low pressure, relatively low hydrogen consumption, and efficient product-oil handling system result in minimal operating costs as well as inexpensive main process equipment. The MRH reactors specialized internal design assures good slurry mixing and gas distribution. Catalyst, suspended in the slurry phase, scavenges metals and coke. Catalyst-free product oil exits from the reactor through a separation zone. A small catalyst purge stream is removed from a separate outlet. Washing, steam stripping, and fluid bed combustion steps remove oil and coke from the catalyst. Regenerated catalyst then returns to the reactor. MRH incorporates Kelloggs HDM process, which was conceived in 1975. In 1980 Idemitsu Kosan Company started developing MRH as a member of RAPAD, sponsored by the Japanese government. With Kelloggs process design and engineering assistance, Idemitsu has built and operated a 1 b/d MRH bench plant. This unit has demonstrated continuous operation and established yields, catalyst requirements, and hydrogen consumption data. MRH achieves 70% conversion of vacuum resid. Typically, 20% to 30% of the distillate products are in the kerosene and gas oil boiling ranges, requiring only minor downstream processing. Metals removal is 90% and desulfurization exceeds 50%. The vacuum gas oil product cut is suitable for feed to Kelloggs heavy oil cracking or to a hydrocracker. Idemitsu has recently started up a 10 b/d MRH pilot plant, also designed by Kellogg, at its research site in Chiba, Japan.

21266 (CONF-850710–, pp. 1281-1290) **CANMET hydrocracking - A Canadian story.** Lunin, G. (Petro-Canada, Don Mills, Ontario (Canada)); Lamarre, J.; Witham, K. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

For the past six years, Petro-Canada, Energy Mines Resources, and Partec Lavalin have been working on a commercialization program designed to develop, demonstrate, and market the CANMET hydrocracking technology. In contrast to other hydrocracking processes, the CANMET process lends itself to a high-capacity, single-reactor-train unit. The product distillates from the process can be readily treated in conventional refinery equipment to produce refinery feed cuts, which are in every way better than coker products. CANMET hydrocracking is capable of processing many types of feed. To date, all feeds tested in the pilot plants have been processed successfully. Tests have been run on more difficult feedstocks to expand the data base. Recently, more emphasis has been put on development than on basic research, in anticipation of challenges likely to arise during the initial operation of the demonstration plant.

21267 (CONF-850710–, pp. 1291-1296) **The Allied process for upgrading heavy crudes.** Murthy, A.K.S. (Allied Corp., Morristown, NJ (USA)); Patel, K.M.; Bekker, A.Y. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Allied process for upgrading heavy crudes and bitumens is based on chemical reactions between water and heavy oil fractions at elevated pressures and subcoking temperatures. For small refineries, this process offers a simple, low cost approach to residual upgrading, with the pitch product being directly usable in most cement plants. Because water is added to the feed in any case, a wet feed can be processed as long as any contaminants are acceptable metallurgically in the process and do not negatively affect the reaction. In the case of in-situ production, it is usually very easy to get the water content of heavy crudes down to the 10% level, but very difficult to achieve the current Canadian 0.5% specification level.

21268 (CONF-850710–, pp. 1327-1334) **New tools for assessing the economic value of heavy crude oils and fractions.** Vercier, P. (Total France, Harfleur (France)); Mouton, M.; Orgebin, J.M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Accurate knowledge of the distillable portion of heavy crude oils or heavy fractions of conventional crude oils is of prime importance for assessing their potential economic value. A new piece of equipment called the DISTACT (distillation a court trajet - short path distillation) is discussed.

21269 (CONF-850710–, pp. 1335-1348) **Hydrotreatment of heavy crudes and residuals.** Kum, H. (INTEVEP S.A., Caracas (Venezuela)); Galiasso, R.; Morales, A.; Garcia, J.; de Salazar, A.; Caprioli, L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Catalysts were developed for hydrotreating (HDS, HDM) and hydrocracking conventional and nonconventional heavy crude oils and residuals characterized by high metal, sulfur, and asphaltene contents. A Ni-Mo/Al_2O_3 catalyst was developed for hydrotreating crude oils from the Orinoco Oil Belt. This catalyst is capable of simultaneous hydrodesulfurization and hydrodemetallization. It was demonstrated that it is possible to obtain operating cycles of 220 days in the processing of Cerro Negro crude, achieving 60% of hydrodesulfurization and 77% of hydrodemetallization. Low-cost catalysts were developed for hydrocracking of residuals, based on naturally-occurring materials (bauxite and laterites), promoted with small quantities of active metals (Mo, Ni). The catalysts developed were used for hydrotreating Cerro Negro, Tia Juana Pesado, and Urdaneta residues. It was established that optimization of the physical properties of catalysts was necessary, according to the type of feedstock, in order to obtain acceptable operating cycles.

21270 (CONF-850710–, pp. 1349-1357) **Advances in the catalytic hydroprocessing of residues and heavy oils.** George, S.E. (Shell Canada Ltd., Oakville, Ontario (Canada)); Yeung, C.K.; Simpson, D.; Van Zijll langhout, W.C.; van Dongen, R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper reviews developments in the Shell residue Hydrodemetallization/Hydrodesulfurization/Hydroconversion (HDM/HDS/HYCON) process. The Shell HDM/HDS process with offstream catalyst replacement is a well-established process. Fixed bed reactors with tailor-made catalyst systems have been in commercial operation with catalyst life cycle of one year and longer. The economics of processing high metals-containing feedstocks is enhanced by the development of the bunker hydrodemetallization reactor. Withdrawal of spent catalyst and addition of regenerated catalyst is done intermittently under operating conditions. With the advent of coke-resistant residue processing catalysts and modifications in process conditions and process line-up, high conversion of the short residue into light oil has been demonstrated on a laboratory scale. The Shell hydroconversion process can be applied to the upgrading of conventional residues, heavy oils, and tar sands. It is also a tool to produce pipelineable synthetic crudes, which can be further processed in conventional refineries.

21271 (CONF-850710–, pp. 1359-1361) **Catalytic hydroprocessing of syncrudes: R and D interests at CANMET.** Kriz, J.F. (CANMET, Ottawa, Ontario (Canada)); Fairbridge, C.; Wilson, M.F. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The efficiency of distillate refining is gaining importance in view of the increasing quantities of synthetic crudes likely to be produced in future years. Canadian synthetic crude oil is now produced commercially from Athabasca oil sands in northern Alberta. The present level of syncrude production (about 10% of total oil production) can expand through new commercial ventures in Alberta and Saskatchewan utilizing oil sand and heavy oil resources, while refinery residual oil upgrading elsewhere may add to the production. In the longer term, coal-derived liquids, obtained through separate processing of coal or coprocessing with oils of petroleum origin, may be included. Since syncrudes are much more difficult to refine than conventional crudes, it has become apparent that accommodation of the increased production of syncrudes in refineries will require modifications in conventional refining methods. The crucial problem with synthetic middle distillates is that they have poor cetane ratings and smoking properties, which result from excessive

concentrations of certain aromatics and the lack of straight-chain paraffins. The presence of heteroatoms becomes important in the overall approach to catalyst development, particularly in preventing raid catalyst deactivation. This paper reviews selected experimental findings of this laboratory related to reaction phenomena in hydroprocessing of synthetic crude distillates. Problems with both oil sand- and coal-derived distillates are addressed and new directions in technology developments are indicated.

21272 (CONF-850710–, pp. 1363-1368) **Idemitsu hydrocracking process produces distillate from residual oil.** Sue, H. (Idemitsu Kosan Co., Ltd., New York, NY (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Idemitsu Kosan Co., Ltd. has developed a new hydrocracking process (Idemitsu HYC process) to produce middle distillate from atmospheric residue as a member of Research Association of Residual Oil Processing (RAROP) under the auspices of the Japanese government. Idemitsu HYC process employs a fixed bed reactor system with a zeolytic catalyst, featuring high middle distillate yield and high tolerance to asphaltenes and metals. A demonstration operation has been carried out to confirm the performance on a commercial scale since 1982. Idemitsu HYC catalyst was loaded together with a conventional HDS catalyst into a commercial residue hydrotreating unit. High middle distillate yield over 25 vol% was maintained for over 5,000 hours, with constant sulfur removal of 80 wt%. Idemitsu is proceeding with catalyst improvement and with an additional demonstrate under the program of the RAROP.

21273 (CONF-850710–, pp. 1369-1377) **A new improved HDM catalyst for heavy crude oils.** Aktius, L. (Eka AB, Surte (Sweden)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A number of catalytic hydrotreating processes have been designed by processors and oil companies. The reactors can be of three main types: fixed bed, bunker and ebullated bed. The last two have moving beds which give lower temperature gradients and less tendency for flow blockage. The various processes show different performance but with the same overall characteristics: sulfur is removed from heavy oil fractions as hydrogen sulfide under the hydrogen pressure and the metals content is decreased. The feed is hydrocracked to different degrees resulting in a product of lower viscosity. The best known use of HDM catalysts is as guard catalysts to extend the life of the HDS catalyst. An HDM catalyst shows a high uptake of metals and a moderate HDS activity. An HDS catalyst has the opposite features.

21274 (CONF-850710–, pp. 1379-1386) **Cracking activity of dealuminated Y-zeolites.** Hassan, S.M. (Mansoura Univ. (Egypt)); BaBaghlaf, O.; Marie, S.A.; Baamer, F.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Sorptive properties of dealuminated zeolites and their cation-exchanged forms have been studied. Exchange of NH_4^+ ions with Ca^{2+} or Ni^{2+} changes the textural characteristics of the dealuminated zeolites and improves their crystallinity and cumene cracking activity. The liquid products of gas oil cracking over the 43.3% dealuminated zeolite are typical gasoline fraction.

21275 (CONF-850710–, pp. 1387-1393) **Kerr-McGee's Rose® process expands on proven extraction technology.** Nelson, S.R. (Kerr-McGee Refining Corp., Oklahoma City, OK (USA)); Corbett, R.W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Residuum Oil Supercritical Extraction (ROSE) process is well known in the petroleum refining industry as a commercially-proven upgrading process. It allows refiners to recover higher value products from atmospheric and vacuum distillation resids while conserving energy. The lighter extracted products are used as feedstocks for catalytic and hydrocracking units and as lube oil blend stocks. The heavier asphaltenes and resins are used in a variety of markets, including asphalt manufacture, binders, and fuel-oil production. An extension of Kerr-McGee's supercritical fluid technology was developed in conjunction with coal liquefaction work, which was done during the last 17 years. ROSE solvent extraction techniques were developed to reject the solid material - unconverted coal and ash - with the heaviest fractions of liquefied coal. Since that time, ROSE Solids Rejection (ROSE-SR) technology has become the industry standard for deashing coal liquefaction products. In addition to this breakthrough in solids removal, the ROSE process is being applied to field upgrading of heavy crudes and integrated into several resid upgrading process combinations.

21276 (CONF-850710–, pp. 1395-1399) **First year operating experience of the LAGOVEN Amuay refinery flexicoker.** Guedez, E.J. (Petroleos de Venezuela (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In the Flexicoking process, high molecular weight hydrocarbons are thermally cracked to lighter, more valuable products. For example, vacuum bottoms are converted into gas oils, naphthas, light ends, and coke. An integral gasifier converts the coke into a low-heating-value gas that is suitable for burning in refinery furnaces and boilers. This paper presents a brief description of the Flexicoking process, and reviews LAGOVEN's objectives in selecting it as the key conversion unit for its Amuay Upgrading Project, completed in 1982. The results of a unit capacity test carried out in early 1983, a discussion of typical process yields and product dispositions, a brief outline of the main problems encountered during the 14-month first run, and a summary of the economic benefits achieved by LAGOVEN from the Flexicokers first year of operation are presented.

21277 (CONF-850710–, pp. 1403-1413) **Concepts for heavy metal handling in heavy oil upgrading processes.** Lehmann, R. (Lurgi GmbH, Frankfurt (West Germany)); Broeckl, R.; Rodriguez-Polanco, D.; Schemel, R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information

Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The production of heavy crudes in the Faja Petrolifera gives rise to a heavy metal charge to the environment, which needs an urgent technological solution. For example, in case of a 100,000 bpd upgrading unit producing in Venezuela a metal-free syncrude, about 3,000 tpy of heavy metals (V + Ni) are extracted. The authors dumping has to be performed without any noteworthy impact to the environment, since the heavy metals, particularly nickel, are poisonous to almost all organisms. The quantities of heavy metals to be disposed in the course of the development of the Faja Petrolifera require, furthermore, careful consideration on economical reuse of these valuable resources. According to the present state of upgrading technology, heavy metals will be mainly concentrated in residual fractions, which will serve as feedstock for energy (steam and power) and hydrogen production; besides this, they may also be concentrated on special carriers (e.g., catalysts) of certain demetallization processes actually under development. For the recovery of heavy metals (mainly vanadium and nickel) from said wastes, a technology has been studied applicable to the various types of residues. To improve the economics, a vanadium recovery process has been designed. The process is characterized by: reductive leaching with sulfuric acid; oxidation; selective precipitation of species. Independent from the option to recover some of the heavy metals, a chemical waste water treatment plant has to be operated within a refinery complex in any case, in order to avoid environmental impact.

21278 (CONF-850710–, pp. 1415-1424) **Organic matter-mineral interaction in oil sands solids.** Kotlyar, L.S.; Sparks, B.D.; Kodama, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The solvent-extraction spherical-agglomeration process has general applicability to all types of oil sands. One of the most important factors in the application of this technique is the amount of residual organic matter tightly bound to the mineral surfaces of some oil sand solids fractions. During the solvent extraction of oil sands, the solids separated from the different process streams were analyzed for particle size distribution and extent of association with the residual organic matter. It has been shown that in all cases the amount of residual organic matter increased with decreasing particle size of the fractionated solids. Also, it has been found that certain chemical and mineralogical properties of bulk oil sands solids and solids separated from the bitumen solution phase were significantly different. Attempts were made to separate the residual organic matter-mineral complexes from oil sands solids. On the basis of data obtained, it is suggested that, for the bulk of the solids, iron oxides are primarily involved in complexation with organic compounds. For the oil wetted solids, separated from the bitumen solution phase, siderite is considered to be the major inorganic component in residual organic matter-mineral association.

21279 (CONF-850710–, pp. 1425-1438) **Beneficiation of heavy metal minerals from oil sands and oil sand tailings by oil phase agglomeration.** Majid, A. (National Research Council of Canada, Ottawa, Ontario (Canada)); Ripmeester, J.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Heavy metal minerals tend to appear selectively concentrated in specific process streams during the hot water separation of bitumen from oil sands. For instance, minerals of titanium, zirconium, iron, copper, nickel, and chromium concentrate in the centrifuge and scroll tailings. As these minerals are preferentially wetted by bitumen, and thus rendered hydrophobic, this property may be used to beneficiate these minerals by using oil phase agglomeration with either syncrude refinery coke or heavy oil as hydrophobic collectors. Materials treated in this manner include Suncor sludge pond tailings, Suncor plant 4 tailings, Syncrude plant 6 tailings, and a low grade oil sand. On suitable agitation, the slurry, consisting of feedstock, water, and collector separated into an aqueous phase and a unitary organic phase, which in turn consisted of residual organic materials, the collector, and heavy metal minerals. The quality of heavy metal concentrate, separated from the organic phase by washing with toluene, depended on the mode and time of agitation, tumbling charge, feed mineral particle size, feed homogeneity, and mineral hydrophobicity. Additional parameters investigated include recovery of residual organics in the tailings and the effect of pH on the aqueous phase. After removal of heavy metal minerals and residual organics from the tailings, its settling behavior improved greatly. Similarly, the rate of air drying of the resulting sediment improved markedly. The suitability for subsequent processing of the heavy metal minerals was also investigated, for instance direct chlorination of the minerals for SiO_2 production. The function of reducing agent during chlorination was taken by the adsorbed organic matter on the minerals, rather than the petroleum coke normally used. The recovery of titanium was quantitative, although the production, titanium tetrachloride, was contaminated with other metal chlorides.

21280 (DOE/BC–89/1/SP, pp. 32.1-32.19) **Thermal front tracking with cross borehole electromagnetic imaging.** Harben, P.E.; Pihlman, M. USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

Field experiments at the Texaco Kern River Field were conducted to identify optimum transmission frequencies and assess the electromagnetic interference problems present in the system. The authors concluded that the transmitter must be operated below 3 MHz for attenuation measurements to be in the conduction regime. Operation in the conduction regime is necessary if you are to correlate images to independent measurements such as the dual induction logs. They also concluded that electromagnetic interference problems become more severe as the frequency is lowered. The authors are currently designing a downhole active transmitter that will operate at 2 MHz. This frequency is low enough to be in the conduction regime and to increase their transmission distance capability but high enough so that they can still drive a 1 or 2 meter antenna. By driving the antenna with a downhole oscillator they dramatically reduce the chance of electromagnetic interference pathways. Future plans are to test the transmitter at the Texaco field site and demonstrate correlation to induction logs. This will be followed by a brine tracing experiment at the same site. They will then move their equipment to a new pilot test site for a substantial series of cooperative experiments with Texaco.

21281 (DOE/BC–89/1/SP, pp. 34.1-34.25) **Influence of a surfactant on the steam production characteristic parameters.** Ziritt, J.L. (INTEVEP, S.A., Los Teques (Venezuela)); Bresolin, G. USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

A study on the steam production characteristic parameters has been carried out to evaluate and understand the results of a cyclic steam-surfactant injection test carried out in the Bolivar Coast in Venezuela. Through the field test performance and displacement laboratory tests it has been determined that steam diversion and oil relative permeability increase are the two main mechanisms responsible for the improved oil production observed in the field test. However, the relative contribution of these mechanisms to oil production is unbalanced, being steam diversion the most important one.

21282 (DOE/BC–89/1/SP, pp. 35.1-35.28) **Transient behavior of foam flow in 1-D porous medium.** Liu, D. USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

This work is a continuation of Ericksons (1986) work on the transient behavior of foam flow in a one-dimensional porous medium. The equipment used is a modified version of that used by Treinen et al (1985). Most studies have dealt with steady state foam injection, but true steady state conditions are rarely achieved for a field project. Few experimental data are available for transient foam flow. The ultimate goal of this work is to develop a predictive model for foam flow in porous media. The first step in creating such a model is to accumulate basic experimental data on transient foam flow. The system studies is a one-dimensional, low temperature, low pressure environment.

21283 (DOE/BC–89/1/SP, pp. 36.1-36.27) **Evaluation of a cyclic steam-surfactant injection pilot test in the Bolivar Coast, Venezuela.** Ziritt, J.L. (INTEVEP, S.A., Los Teques (Venezuela)); Rivas, O.; Bresolin, G. USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

In this report the authors present laboratory and field test results of steam soak with surfactant additives. Sixteen wells in the Bolivar Coast of Lake Maracaibo were steam-foamed using two commercial surfactants under different operating conditions. For the pilot test they selected wells which covered different characteristics and stages of drainage in the Bolivar Coast. Parameters such as injection pressure surfactant concentration, presence of an electrolyte and a non-condensable gas and steam quality were changed during the test. Flowmeters were run with each set of conditions and results were evaluated by a mathematical procedure which gives the Steam Divertion Factor. Additionally, the actual production performance was compared with the predicted production for a conventional cycle. Even though the production cycle of the steam-foamed wells has not been completed, results at present show an average incremental oil production of 24%.

21284 (DOE/BC–89/1/SP, pp. 37.1-37.26) **Thermal recovery of light crude oils using steam - A laboratory study using a two-dimensional physical model.** Strycker, A. (IIT Research Institute, Bartlesville, OK (USA)). USDOE Bartlesville Project Office, OK (USA); INTEVEP, Filial de Petroleos de Venezuela, SA, Caracas (Venezuela). Nov 1988. In *Fourth amendment and extension to Annex IV, enhanced oil recovery thermal processes.* Order Number DE89000702. Available from NTIS, PC A08/MF A01.

Although steamflooding is traditionally used to recover heavy oils, some pilot projects have demonstrated steamflooding to be an effective technique for recovering higher gravity oils. In contrast to steamflooding of heavy crude oil reservoirs, steam distillation is predicted to be more important and gravity override less important for light crude oils. In this investigation, the authors compared results from the steamflooding of four light crude oils with that of a heavy oil. Most of the experiments were conducted using a two-dimensional physical model. In addition to the usual measurement of oil recoveries, compositional analyses of the crude oils, produced oils and residual oils in the sandpack were made to determine what compositional changes occurred during the steamfloods. The study showed that recovery efficiencies of light oil steamfloods are strongly influenced by the chemical nature of the crude and that substantial gravity override of steam remains a potential problem for light oil steam-flooding. The reported numerical simulation findings of a piston-like steam movement in light oil reservoirs were not validated by the data resulting from this study. The residual oil saturation at the bottom of the model was substantially higher than that from the top of the model. An analysis of the residual oil at various levels in the model also indicated that the oil remaining near the bottom of the model contained greater concentrations of the lighter components than the residual oil near the top of the model.

21285 (DOE/BC/10302–46) **Genetic, physiological and nutritional studies on Clostridium strains isolated and screened for characteristics useful in enhanced oil recovery, with special reference to high salt tolerance: Final report.** Grula, M.M.; Russell, H.H. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Botany and Microbiology. Mar 1990. 114p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AS22-80BC10302. Order Number DE90000228. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This work is concerned with a group of microorganisms generally thought to have the highest potential for usefulness in microbial enhancement of oil recovery (MEOR), namely, fermentative species of the genus Clostridium. The report consists of two parts: (1) a study of the effects of various environmental factors (mainly chemical) on growth, gas production, sporulation, and spore germination of several strains of Clostridium in laboratory media; and (2) a study of the effects of core minerals and pore volume on solvent, acid, and gas production and refeedability (in cores) of similar freshly isolated Clostridium strains. In addition, the bacterial strains were characterized, and their basic nutritional requirements were determined. 15 refs., 27 figs., 37 tabs.

21286 (DOE/BC/10846–15) **Modelling and scale-up of chemical flooding: Third annual and Final report for the period October 1987–September 1988.** Pope, G.A.; Lake, L.W.; Sepehrnoori, K. Texas Univ., Austin, TX (USA). Dept. of Petroleum Engineering. Mar 1990. 230p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-85BC10846. Order Number DE90000226. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The objective of this research is to develop, validate, and apply a comprehensive chemical flooding simulator for chemical recovery processes involving surfactants, polymers, and alkaline chemicals in various combinations. This integrated program includes components of laboratory experiments, physical property modelling, scale-up theory, and numerical analysis as necessary and integral components of the simulation activity. We have continued to develop, test, and apply our chemical flooding simulator (UTCHEM) to a wide variety of laboratory and reservoir problems involving tracers, polymers, polymer gels, surfactants, and alkaline agents. Part I is an update on the Application of Higher-Order Methods in Chemical Flooding Simulation. This update focuses on the comparison of grid orientation effects for four different numerical methods implemented in UTCHEM. Part II is on Simulation Design Studies and is a continuation of Saad's Big Muddy surfactant pilot simulation study reported last year. Part III reports on the Simulation of Gravity Effects under conditions similar to those of some of the oil reservoirs in the North Sea. Part IV is on Determining Oil Saturation from Interwell Tracers UTCHEM is used for large-scale interwell tracer tests. A systematic procedure for estimating oil saturation from interwell tracer data is developed and a specific example based on the actual field data provided by Sun E&P Co. is given. Part V reports on the Application of Vectorization and Microtasking for Reservoir Simulation. Part VI reports on Alkaline Simulation. The alkaline/surfactant/polymer flood compositional simulator (UTCHEM) reported last year is further extended to include reactions involving chemical species containing magnesium, aluminium and silicon as constituent elements. Part VII reports on permeability and trapping of microemulsion.

21287 (LA-UR–90-564) **Microseismic monitoring of the Chaveroo oil field, New Mexico.** Rutledge, J.T.; Albright, J.N. Los Alamos National Lab., NM (USA). 6 Feb 1990. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-36. (CONF-900426–1: 7. symposium on enhanced oil recovery: global prospects and perspectives, Tulsa, OK (USA), 22-25 Apr 1990).

Order Number DE90007543. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Microseismicity was monitored in the Chaveroo oil field in southeastern New Mexico during, and for 5 weeks following, a pressurized stimulation of a well being prepared as an injector for a water flood operation. Three-thousand barrels of water were injected into the reservoir over a 5.5-hour period. Little seismicity was detected during the stimulation. Intermittent monitoring over a 5-week period following the injection indicated detectable seismicity occurring with activity levels varying in time. The most active period recorded occurred just after production resumed in the immediate area of the monitor well. Mapping the microearthquakes using the hodogram technique indicates the events occur along linear trends which corroborate known structural trends of the field. Seismicity trends were defined both parallel and perpendicular to the regionally defined maximum horizontal stress direction. Seventy-three good quality events were recorded, in a cumulative 24 hour period, from which structures were mapped up to 3000 ft from the monitor well. 13 refs., 9 figs.

21288 (NIPER–388) **A three-dimensional, three-phase, simulator for permeability modification treatments using gelled polymers.** Gao, H.W.; Chang, M.M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Mar 1990. 77p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90000227. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A three-dimensional, (oil, water, and gas) simulator was developed by incorporating an in situ gelation model into a black oil simulator (BOAST). This simulator can be used to design permeability modification treatments and to assess the applicability of the method in oil fields using crosslinked polymer gels. Features of the simulator include: transport of each chemical species of the polymer/crosslinker system in porous media, gelation reaction kinetics of the polymer with crosslinking agents, rheology of the polymer and gel, inaccessible pore volume to macromolecules, adsorption of chemical species on rock surfaces, retention of gel on the rock matrix, and permeability reduction caused by the adsorption of polymer and gel. The simulator was validated by comparing the results of simulation runs on an in situ gelation model and polymer flooding with data reported in the literature. Three-dimensional sensitivity runs were performed using a two-layer reservoir model with a horizontal permeability contrast of 10:1 to investigate the effect of vertical to horizontal permeability contrast on incremental oil recovery and to determine the optimal time for initiation of a polymer gel treatment in a waterflood. 35 refs., 35 figs., 11 tabs.

21289 (NIPER–461) **Review of EOR [enhanced oil recovery] project trends and thermal EOR [enhanced oil recovery] technology.** Pautz, J.F.; Sarathi, P.; Thomas, R. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Mar 1990. 66p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90000225. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Information on United States (US) enhanced oil recovery (EOR) projects is analyzed to discern trends in applications of EOR technologies. This work is based on an evaluation of current literature and analysis of the Department of Energy (DOE) EOR project data base which contains information on over 1,300 projects. Three-quarters of current US oil production attributed to EOR is derived from thermal EOR processes (TEOR). Changes in the technology of TEOR since the 1984 "Enhanced Oil Recovery" study by the National Petroleum Council (NPC) are reviewed in terms of the current applied technology and reported research. 87 refs., 4 figs., 20 tabs.

21290 (NMRDI–2-75-5231) **Adsorption properties of carbon dioxide enchanced oil recovery additives: Final report.** Patton, J.T.; Holbrook, S.T. New Mexico State Univ., Las Cruces, NM (USA). Dept. of Chemical Engineering. Jan 1990. 65p. Sponsored by New Mexico Research and Development Institute. Order Number DE90007781. Available from NTIS, PC A04/MF A01; OSTI; New Mexico Research and Development Institute Suite M, 457 Washington, S.E., Albuquerque, NM 87108.

The selection of the optimum foaming agent (surfactant) for enhancing oil production by carbon dioxide flooding is based on foamability and adsorption. Measurements of adsorption on carbonate cores from New Mexico reservoirs showed large adsorption differences between three commercial, high-foaming surfactants. An ethoxylated alcohol structure was at least adsorbed, 0.64 mg/cc pore volume; an ethoxylated alcohol sulfate was next, 0.74 mg/cc pore volume; the highest adsorbed was a glyceryl sulfonate, 2.30 mg/cc pore volume. Commercial application of the foaming additive involves injecting alternate slugs of surfactant solution and carbon dioxide. Surfactant concentration should be determined to allow for the adsorption above. 9 refs., 27 figs., 6 tabs.

21291 (NOIA–89-05124) **Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.** Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. 413p. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The main theme of this conference was design, construction and environmental impact of offshore drilling installations. Major topics covered included: floating production systems; certification and quality assurance; and cost-effective design and construction. Separate abstracts have been prepared for 16 papers.

21292 (NOIA–89-05124, pp. 311-324) **A new generation control system.** Gomm, L. (Bailey Controls, Burlington, ON (Canada)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper describes the state-of-the-art offshore rig design of the Statoil Veslefrikk platform. Its various functions, such as production process control and data acquisition, fire and gas safety systems and safety shutdown functions are all integrated in an advanced distributed control system. This system is a departure from the traditional discrete function system. This integration represents the present and future configuration in offshore platform control strategy. The distributed control functions are in constant communication with each other and the operators in the central control room via a redundant plant loop snaking throughout the platforms. The control functions, though in constant communication are within themselves redundant and independent. Attractive convetional mimic/matrix panels are driven entirely from the distributed system. The paper gives the description of the man-made interface as console designed keyboards for process control. The operators can access graphic displays depicting any function in the distributed system through a single keystroke. 4 refs., 2 figs.

21293 (NOIA–89-05124, pp. 373-389) **Weight savings in drilling facilities.** Lindekleiv, A. (Maritime Hydraulics A/S (Norway)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

As drilling for oil and gas has moved into deeper waters, the need for lighter weight equipment has become evident. Despite this need, the drilling modules have grown heavier and heavier. The paper reviews the reasons for the weight increase in the drilling modules including increased demand for automation, mechanization of equipment, and increased demand for redundancy and back-up systems. The dramatic increase in the ratio between the weight of the drilling and topside modules over the years is shown. This weight increase has no relation to the water depth, but can

probably be linked to oil production capacity. The main objective of the project described in this paper was to discover ways to reverse this trend and save weight. The main ways by which a total weight saving of 485 tonnes was achieved by using MH-Hydraulic equipment in place of conventional equipment in the design of Norwegian offshore installations is outlined. The main components involved in these weight saving were, hydraulic drawwork; hydraulic mud pumps, hydraulic top drive, and hydraulic rotary table. It was concluded that for each tonne saved on equipment, about 3 tonnes of structural steel can be saved. 2 figs.

21294 (NOIA–89-05124, pp. 360-372) **Drilling module weight reduction.** Thorsrud, A. (Aker Drilling A/S (Norway)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper describes the weight reduction of offshore drilling facilities and outlines what can be achieved by optimization. It reviews some projects, including the Sleipner Project in the North Sea, which have resulted in weight saving. It has been estimated that a reduction of 1800 million tonnes to traditional drilling modules is possible, and another 1000 million tonnes could be saved by reducing the size of wellhead modules. The key factors, (such as knowhow, defined design basis, flexibility, use of temporary add-on of equipment), required to achieve the optimal solutions in respect of weight/volume/cost are identified. These factors are: resource recovery schedules allowing for establishment of a realistic drilling programmes; properly defined design basis and the knowledge of how to define the normal design cases; and simple, flexible and effective system design, based on sound knowledge of what's required for the specific tasks. Without introducing any new technology it is possible to reduce weight in the order of 30%. Even more can be achieved if effort is put into developing new and efficient equipment. Additional cost saving will be achieved by full or partial re-use of both equipment and modules. 5 figs.

21295 (NOIA–89-05124, pp. 335-359) **Techniques for topside weight reduction.** Hewlett, D. (Nortek Engineering Inc., St. John's, NF (Canada)); Wilson, P. Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Reduced oil prices, development of margina oil fields, and progression into deeper waters have all contributed to the need for cost effective offshore developments. Topside weigh reduction has become a serious topic of late, and the survival of many future offshore projects hinges on the savings it promises. This paper is an overview of topside weight reduction techniques incorporating aspects of front end engineering (FEE), the use of new materials and alternative fabrication techniques, and innovative equipment technology. Front end engineering involves optimization of platform facilities during the planning and design stages. FEE practices which can lead to significant weight reduction includes: the optimization of the number of oil-gas-water separation trains. The recommended option includes the use of two separation trains with piggybacked horizontal separators. The number of separation stages should also be reviewd carefully. power generation should be selected based on the phased power consumption requirements for drilling, personnel support, reservoir support and production. Phasing allows the use of generation for multiple applications as the field ages. Significant weight savings can be achieved by the use of new materials such as aluminum, high strength steels and fiber reinforced plastics. Innovative equipment which can result in weight reductions includes the use lightweight back-washable polypropylene filters and catalytic deoxygenators for seawater treatment, elimination of oil lubrication systems, the use of plate-fin designs for heat exchangers in treating seawater for injection. 17 refs., 6 figs., 2 tabs.

21296 (NOIA–89-05124, pp. 324-334) **Designing for platform removal.** Penney, W. (univ. of Newcastle Upon Tyne, Newcastle Upon Tyne, (England)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The 1958 Geneva Convention and new guidelines drawn up by the International Maritime Organization in 1989 require that any maritime installation, including offshore oil/gas installations, which are abandoned or disused, be removed and disposed of in some safe way. This paper discusses the alternative for design of an offshore drilling structure with ultimate removal in mind. Consideration must be given to the weather and ice conditions in which construction, operations and dissembly must take place and of the geology of the ocean bed in which it sits. Rigs may be redesigned to be dismantled and removed in large modules, or piecemeal. The jacket may be dismantled, removed as a single piece or refloated. The dismantled installation may be dumped in deep water, used to create an artificial reef or brought ashore in accordance with economic or regulatory considerations. Removal of a structure as soon as its active life is finished should be planned, as structures which are abandoned for considerable periods before removal is attempted may become difficult, dangerous, and expensive to remove. Guidelines are provided for designers of offshore structures. 7 refs., 2 figs., 1 tab.

21297 (PCCIM–CE02873, pp. 35-35.13, Paper 35) **Experience with fireflooding in Countess "B" Pool, Alberta reservoir aspects.** Metwally, M. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

This paper discusses the reservoir aspects of the Countess B Fireflood Pilot Project in Southeast Alberta. Initiated in 1983 and expected to continue until 1991. The Countess B pool is a Glauconitic channel sandstone and has been under waterflood since 1973. This 16 hectares inverted five-spot set includes one injector well and four producing wells. The pilot was designed to determine the level of incremental recovery that could be achieved from the process application and to obtain operating experience from a reservoir containing light oil. An extensive program of well testing and fluid analysis has been conducted to identify and evaluate the pilot performance. A research program supported and operated by the Alberta Oil Sands Technology Research Authority is also being conducted to provide a better understanding of the process application in this pool. The results suggest that a waterflooded light oil reservoir can be fireflooded successfully. A mineralogical examination of a post-combustion core indicates that the temperature of the fire front is 300-400C and the oil is effectively displaced. To the end of 1988, the cumulative burned volume represented 20% of the pilot volume. The incremental recovery is expected to range from 10 to 18% of the original oil in place at the termination of the final phase which is expected to start in early 1990 and to be completed in the late 1991. To date, the pilot has achieved most of its objectives and will likely achieve the remaining objectives prior to its termination. 6 refs., 8 figs., 3 tabs.

21298 (PRM–CE02870, pp. 37) **Subsea multiwell silo drilling/production system.** Ames, T. J.; Ott, R. E.; Lunn, I. S.; Batenburg, L. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986;

CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The Multiwell Silo Drilling/Production System (MSDP) is designed to provide maximum protection of a clustered subsea completion system in areas where damage from fishing vessels or anchor drag is a high probability. The MSDP system uses existing technology to provide a completely protected, low profile structure around a 4-well template. Drilling and completion equipment is standard with only nominal modifications required to guidance systems for installation. The system consists of a large diameter silo installed flush with the mudline. A 4-slot template in the bottom of the silo establishes spacing for up to 4 wells and a connection point for a centrally located manifold for commingling production and annulus access from each well. A protective frustum structure covers the silo providing deflection for trawl boards, nets and anchors. A center lid can be removed for access to the christmas trees, chokes, controls and manifold piping. A manifold, christmas trees and control systems are installed using guidelines and diver assistance for connection to trees to the manifold and attachment of control umbilical. An electrohydraulic multiplex system will be used as the primary control system for the manifold, trees and adjustable chokes. Sequenced hydraulics will provide backup control capability. Flowline connections will be made diver assisted and all flowlines and umbilicals will be buried up to the protective frustum structure. A pipe chase within the protective structure completely shields the flowlines and umbilical from trawl boards or nets. 12 figs.

21299 (PRM–CE02870, pp. 21) **A review of the drilling activities on the Amauligak structure using the Beaudril Molikpaq vessel.** Thomas, T.J.; Pidcock, G.A. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Three wells were drilled in the Beaufort Sea in the 1985-1986 season from the Molikpaq, a bottom-founded steel caisson. The first well was drilled to the northeast of the surface location to test for oil bearing formations updip from the Amauligak discovery well. The second well was drilled to the northwest to test the sealing nature of a north-south fault and the distribution of hydrocarbon bearing zones. The third well was drilled eastward to confirm reserves beyond a minor fault and to provide further information on reservoir parameters. The drilling of all 3 wells was satisfactorily completed. Details are provided of various technical aspects of this drilling program, with special reference to those areas of new and unusual engineering techniques. Casing design did not present major difficulties, and the reasons for particular casing sizes and setting depths are presented. A unitized wellhead was used incorporating mandrel type hangers and seal assemblies. Water based drilling fluids were used, with additives employed as needed to control active shales. Directional drilling profiles and procedures were extensively planned, and all 3 wells were drilled below the same 508-mm casing shoe. Pilot holes were used in the kickoff sections to give maximum directional control, which was more difficult in the deeper hold sections. A newly developed north-referencing rate gyro was found to be an accurate repeatable survey instrument. Bit selection was dominated by the use of medium soft tricone bits down to 3500 m; center jet nozzles were found useful in shallower sticky sections. Well logging was satisfactorily performed and successful tests were performed on the third well, which had crude oil flow rates of over 16,000 bbl/d. 9 figs.

21300 (PRM–CE02870, pp. 25) **Beaufort Sea drilling with low toxicity oil based mud.** Johancsik, C.A. (Esso Resources Canada Ltd. (Canada)); Grieve, W.R. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Oil-based muds are an accepted means of eliminating drilling problems resulting from the interaction of formation clays with water-based mud. In the Beaufort Sea, use of oil-based mud was demonstrated at the Nipterk L-19 well, where hole problems were virtually eliminated and the average rate of penetration more than doubled. This provided an incentive to use oil-based mud in 2 more offshore wells: Adgo G-24, a high angle directional delineation well, and Minuk I-53, a vertical exploration well. Two main topics are discussed: compliance with regulatory and environmental concerns related to disposal of drill cuttings; and the technical aspects of drilling with oil-based mud in the Beaufort Sea, where structural instabilities in the wellbore can cause problems no matter what type of mud is used. The experience from the Nipterk well was used in planning the Adgo and Minuk wells with regard for base oil selection, mud formulation, solids-control equipment and operation, and oil retention. Base oil was selected to have a low viscosity and pour point, minimum reactivity with rubber, sufficiently high flash point, no fluorescence, and low toxicity. The solids control and ventilation systems on the drill rigs were modified to be suitable for oil based mud. The Adgo well was drilled successfully, with hole instability problems being solved by using a higher mud density. At Minuk, the average penetration rate was 15% higher than with control wells; this and other benefits of using oil-based mud translated into very significant cost savings. Some problems with insufficient shaker and centrifuge capacity in the solids control system were encountered. These will be corrected in future drilling projects by using higher capacity equipment. 5 figs., 2 tabs.

21301 (PRM–CE02870, pp. 21) **Gloryhole tool design, fabrication and opeation.** Stewart, H.R. (Gulf Canada Corp. (Canada)); Goudoever, T.V.; MacGregor, I.; Isted, R.E. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC , Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

This paper describes the design, fabrication and operation of a 24 ft diameter drill bit which is used to drill retained or unretained gloryholes to protect wellheads and blowout preventers from ice keel damage. The system employs mechanical teeth and water jets to cut the soil, which is then removed using an airlift system. The main cutterhead is rotated by a hydraulic ratchet assembly. The design facilitated inexpensive fabrication in a constrained time frame. The tool was designed for operation from a conical drilling unit which operated in the Beaufort Sea. Prototype tests were conducted near Calgary, Alberta and the viability of the drill system was successfully demonstrated. Field tests were then conducted at the Kringalik site in the Beaufort Sea, selected because of the similarity of its surface strategy and shear strengths to parts of the Alaskan shelf, Results indicate that this equipment has greatly increased the flexibility of the drilling unit since wellsites no longer require site preparation by other vessels. The field testing further indicates that the design of the tool has been justified technically and is coast efficient compared to the conventional methods of preparing gloryholes. 1 ref., 16 figs., 1 tab.

0204 Processing

Refer also to citation(s) 21415, 21416

21302 (CEG–C212.0002) **Fluidized-bed catalytic cracking (FFC) catalyst fabrication: Final report and appendix.** Cambrian Engineering Group Ltd., Mississauga, ON (Canada). Dec 1988. 457p. Contract EMR 03SQ-23440-7-9124. (MICROLOG–89-04486).

Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A plant is being constructed to extract valuable materials from flyash produced by an Alberta oil sands processor. A by-product of the extraction is a leach residue which has been reported to contain as much as 95% of zeolitic material. Preliminary tests on the leach residue for catalytic cracking activity indicated that the residue had good potential as a low-cost fluidized-bed catalyst. A project was undertaken to evaluate the usefulness of the leach residue by-product in a number of applications, and in particular as an FCC catalyst. A literature search on the properties and uses of zeolites was conducted. The leach residue was charaterized and the properties compared to the specifications of the industrial products. The physical and chemical properties of the residue indicated that the residue would not be suitable for use in detergents, catalysts and microsieves. In addition, the zeolite phase did not have the faujasite structure that is commonly present in these three applications. However, it appeared to be suitable as a filler material, although its high metals contents might cause problems. The leach residue was tested in the above 4 applications. The experimental results generally agreed with the predictions made from comparing the properties of the residue with the specifications of the commercial products. The leach residue possesses catalytic activity. However, in its present form it cannot compete with commercial FCC catalysts that are twice as active. The literature survey, analytical work and experimental results of this project clearly indicate the extensive chemical and physical changes to the residue that will be required to make it competitive from a reaction point of view. 53 refs., 113 figs., 111 tabs.

21303 (DOE/PC/88810–4) **Development of analytical procedures for coprocessing: Quarterly technical progress report for the period July 1 through September 30, 1989.** Vogh, J.W.; Anderson, R.P. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1989. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88810. Order Number DE90007423. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this work is development of methods for determination of composition of coprocessing products and the relation to the residue and coal reactants. The purpose of this is to measure the contribution of residue and coal individually to the formation of product components or compound classes. A series of coprocessing reactions have been carried out to generate materials for analysis. Maya residue, bp >1000° F, and Illinois No. 6 coal have been converted using dispersed molybdenum catalyst at 445° C for one hour under 1800 psi (cold pressure) hydrogen. The reactions were run at 2, 20, 30, and 40 percent loading of coal. Overall yields and production of gas, liquid, and solid products are reported. 6 refs., 3 figs., 11 tabs.

21304 (WU/CE–90-00179) **Effect of pressure and temperature on the surface tens!on and viscosity: Final report.** Scott, D.S. A.G. (University of Waterloo, Waterloo, ON (Canada)); Radlein, D. St. A.G. Waterloo Univ., ON (Canada). Dept. of Chemical Engineering; Laurentian Univ., Sudbury, ON (Canada). School of Engineering. Sep 1988. 63p. Contract EMR 23440-7-9-9065/01-55. (MICROLOG–90-00179). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The viscosity and the surface tension of the liquid hydrocarbon phase contribute one of the greatest degrees of uncertainty in the selection of reasonably correct values for use in modelling a hydrocracking process. A review of existing theory, and of recommended empirical and semi-empirical correlations suggests that neither surface tension nor viscosity is likely to be accurately predictable at reaction conditions for the range of hydrocarbon feedstocks likely to be used. In particular, values of the dynamic surface tension are difficult to predict. A literature survey examined methods for measurement of surface tensions or viscosities. Those methods which could potentially be used at high temperatures (to 450C) and at high pressures (to 17 megapascals) were selected for further evaluation. The expected effects of pressure, temperature, time, and gas-liquid solubility equibrium were summarized. The mazimum bubble pressure method for the measurement of dynamic and static surface tension was selected as potentially the most suitable for the desired range of conditions. The drop formation method could also be used but was judged to be experimentally somewhat more difficult and less appropriate. For the measurement of viscosity, the linear oscillation viscometer would be the first choice, on the grounds of ease of use and simplicity of construction. The method could also be adapted to measure fluid densities and for use with suspensions. A second, but less desirable, choice would be the rolling ball viscosimeter. 40 refs., 8 figs.

0205 Products and By-Products

21305 (AD-A–214497/0/XAB) **US Navy mobility fuels: Worldwide survey and analysis of both commercial and Navy fuels. Final report.** Woodward, P.W.; Shay, J.Y. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Jul 1989. 36p. (NIPER–428). Available from NTIS, PC A03/MF A01.

Quality and worldwide availability of distillate fuels have become increasing concerns to the U.S. Department of Defense. In response to these concerns, the David Taylor Research Center (DTRC) has conducted a worldwide survey of such fuels through a contract with the National Institute for Petroleum and Energy Research (NIPER). Representative fuels were collected at both Navy and commercial ports around the world through a NIPER subcontract to ABS Worldwide Technical Services (ABSTECH). The collected fuels were Naval Distillate Fuel (MIL-F-16884H, NATO F-76), Marine Gas Oil (MGO), Heavy Marine Gas Oil (HMGO), and Marine Diesel Fuel (MDF) for the Navy; Automotive/Truck Diesel for the Army; and Aviation Turbine Fuel (MIL-T-5624L, NATO JP-5) for the Naval Air Propulsion Center. The Navy F-76 fuel samples were characterized at NIPER by 44 different fuel property analyses.

21306 (AD-A–214845/0/XAB) **CRC (Coordinating Research Council) octane number requirement survey, 1988.** Coordinating Research Council, Inc., Atlanta, GA (USA). Aug 1989. 165p. (CRC–566). Available from NTIS, PC A08/MF A01.

An annual statistical survey of octane number requirements of late-model vehicles is conducted by the Coordinating Research Council, Inc. Test data were obtained by nineteen companies on 391 1988 vehicles including passenger cars and light-duty trucks and vans, of which 155 were equipped with knock sensors. Maximum octane-number requirements were determined by testing at maximum-throttle conditions, as well as at part-throttle, with three unleaded fuel series of varying sensitivities. Requirements are expressed as the (R+M)/2 octane number, Research octane number, and Motor octane number of the reference fuel producing knock which was recurrent and repeatable at the lowest audible level. Estimated octane number requirements for the total vehicles are weighted in proportion to the 1988-vehicle-model production and/or sales figures. The maximum octane number requirements of 1988 models with average sensitivity unleaded fuels were 84.7 (R+M)/2 octane numbers at the 50% satisfaction level, and 89.3 (R+M)/2 octane numbers at the 90% satisfaction level. Comparison with previous Surveys are made in this report.

0206 Health and Safety

Refer also to citation(s) 21292

21307 (PRM–CE02870, pp. 14) **A unique offshore oil rig escape system.** Nuytten, P.; Hauptmann, E. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and

Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A special purpose underwater survival pod, called CUSP, is being developed to allow the crew of an offshore platform to ride out severe storms or sudden emergencies. CUSP consists of a cylindrical cabin designed to operate at a nominal depth of 100 feet, and capable of returning to the surface at any time. Standard life-support, food, water, and medical supplies are on board. A communications buoy enables location of the CUSP from surface vessels and communication with other CUSPs as well as with operations and rescue personnel. In an emergency, personnel can rapidly enter the CUSP via the top hatch and a fireman-type slide, the hatch is closed, and the CUSP is dropped into the water. An anchor keeps the CUSP at its predetermined depth for as long as necessary. This project is currently at the preliminary design stage. 5 figs.

21308 (PRM–CE02870, pp. 6) **Paramedical concerns in Arctic offshore safety.** MacLachlan, D.A. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A review of the types, names, and qualifications of the various safety health care workers is presented, including recent legislation in Alberta (and the Northwest Territories) controlling educational standards and maintenance of licensure. It is shown that standards for health worker qualifications vary between different jurisdictions in Canada. Thus demonstrating the need for careful scrutiny of the qualifications of paramedical personnel and the medical care given by them. Points to consider when reviewing bids for paramedical work and special cases, such as sour gas, remote areas and diving medical safety are addressed. Selection of equipment, both consumables such as dressings and drugs, and non-consumables such as strechers and oxygen tanks, is also discussed. One significant conclusion is that the extra cost of adding certain higher-qualified personnel capable of advanced care, such as suturing, could be more than offset by the consequent avoidance of the need for an emergency evacuation.

21309 (PRM–CE02870, pp. 4) **The Watercraft Offshore Canada Ltd. Arctic escape system project.** Seligman, B.H.W.J. (Watercraft Offshore Canada Ltd. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A full-scale prototype rescue vehicle called ARKTOS was designed and built to meet the desire for an improved evacuation system capable of operating in the Beaufort Sea. The objectives of this system were to meet all the criteria of a standard totally-enclosed lifeboat, as well as the capability of working at temperatures of −50° C and in high winds on any ice surface experienced in that region. The prototype successfully underwent water trials in Vancouver and a 120-mile journey down the Mackenzie River and through sea ice to Tuktoyaktuk. Many weeks of testing were also completed in the Arctic in which all kinds of ice conditions were successfully handled. The operational experience gained is being used to design an improved model called ARKTOS ALPHA. The vehicle is felt to have potential applications not only in rescue work, but also in many other small vessel ice/water transition problems such as survey work, oil spill response, and general transportation.

21310 (PRM–CE02870, pp. 19) **Risk management offshore, do we have it right?.** Pomfret, B. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Risk management has one basic goal: to protect corporate assets and profits by reducing the potential for loss before it occurs. In offshore operations, its aim is to minimize or eliminate the risk before rigs are destroyed by fire and/or environmental forces, and before the company is fined for infringements of the law. The basic steps to the preparation and execution of a risk management plan are summarized, starting with the identification of pure risks (i.e. where there is a chance of a loss but no chance of a gain). The next step is to measure the loss potential of incidents; in offshore operations, this step is often omitted, but it is necessary to gain and maintain the interest of executive management. The evaluation of various methods of treating risks, and the selection of the most advantageous method, involves determination of the chance of a loss occurring as a result of the risk, the maximum amount of loss, and the financial resources available to meet such loss. In this regard, the loss unit concept was developed to remind managers of the possibility of multiple risks associated with a single event. Methods of managing risks include termination or complete avoidance of a risk, loss prevention and reduction, such as the use of protective devices; risk transfer, such as insurance, which is seen to be the most expensive form of risk treatment and to be avoided if possible; and risk retention in cases where the chance or cost of risk is sufficiently small. Implementation of a risk management program starts with a commitment from the top management and requires coordination and communication with departments such as those responsible for safety and loss control.

21311 (PRM–CE02870, pp. 21) **Comprehensive planning results in good safety statistics.** Fercho, E. (Canadian Marine Drilling Ltd. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A Canadian drilling company operating in the Beaufort Sea has had an excellent safety record in an area where abnormal pressures are common and well-defined safety measures are required. This experience has demonstrated that comprehensive planning for offshore drilling operations in Arctic conditions will result in improved safety performance. Each operation must be properly planned, with special care and attention given to equipment preparation, training of personnel, and preparation of relevant safety and emergency response procedures. Safety management begins with the top management, and line managers are fully responsible for operating safely. An independent safety department actively promotes safety, performs inspections, and provides full support to line management and workers throughout its accident prevention program. The company's comprehensive planning has also made it possible to increase productivity and improve operational efficiency; for example, during the 1976-1985 period, the average time required to run casing had been reduced by 25%. 3 figs., 3 tabs.

21312 (PRM–CE02870, pp. 17) **Accident prevention management: A pro-active approach.** Westermark, L.N. (Esso Resourses Canada Ltd. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

This paper describes the underlying philosophies which Esso Resources used during the execution of their Beaufort Farmout

Agreements in the Beaufort Sea operations in the period 1982-1986. Top level management involvement in the loss control process is the basis for creating a positive attitude amongst all project members. Techniques for developing a sense of ownership and committment at every level of the operator's organization and in the organizations of all of the contractors are discussed. Specific tasks during the four year period which represented major loss control achievements and occasional setbacks are described. These events show the importance of demonstrating the Project manager's commitment ot people and their safety; overall project success can only be achieved when every individual in the project takes responsibility for its safe execution.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21208, 21887

21313 (CERI–31) **Canadian crude oil supply/demand balances.** Tanner, J.N.; Reinsch, A.E. Canadian Energy Research Inst., Calgary, AB (Canada). Aug 1989. 342p. (MICROLOG–90-01035). Available from PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This study examines the existing situation relating to crude oil supply and refined petroleum product demand in Canada and, based on reasonable assumptions regarding future energy prices and economic development, provides an analysis of likely future paths of crude oil supply-demand balances. An important component of this research is the assessment of conventional, nonconventional and frontier sources of crude oil supply and an evaluation of the oil megaproject agreements announced in 1988, a partial response to the concern over increasing exposure of the Canadian economy to imports of foreign light crude oil. The supply projections are set against a forecast of Canadian refined petroleum product demand and the resulting light and heavy oil balances are examined. It is concluded that, under a reasonable forecast of crude oil prices, Canada will face a decline in conventional crude oil production through the 1990s and a rapidly growing deficit in light crude oil balances, although recent discoveries in British Columbia may provide a temporary delay. It is also concluded through the analysis of the megaprojects announced in 1988 that these costs are generally higher than the costs of producing conventional light and heavy oil from the western sedimentary basin. 27 refs., 17 figs., 72 tabs.

21314 (CONF-850710–, pp. 21-24) **Heavy crude oil markets.** Hermes, R.A.; Manning, T.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The demand for heavy crude oil is a function of the market for vacuum bottoms as a boiler fuel (both stationary and a bunker fuel) and as feedstock to conversion units in refineries, such as cokers. During the early 1980s, heavy crudes were in long supply and prices were depressed relative light crudes. In attempt to take advantage of this, refiners began to build facilities to utilize the heavy crudes. Utilities had also begun to shift toward alternative fuels in the belief that heavy crude would continue to be in surplus. Unforunately, total demand for crude oil dropped with OPEC acting as a swing producer and heavy crude oilu availability dropped below the apparent demand. The price differential between light and heavy crude oil narrowed significantly. The British coal strike further increased demand and kept prices for heavy crude oil firm while light crude oil prices weakened. This paper will address the future availability of heavy crude oil relative to the deman for vacuum bottoms and demonstrate how the utilization of the world's refinery conversion equipment can be used to forecast the differential between heavy and light crude oil, expressed as an incremental return on coking.

21315 (CONF-850710–, pp. 49-54) **Heavy oil and the potential of thermal recovery in the United States.** Stosur, G. (Dept. of Energy, Washington, DC (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Even though thermal oil recovery methods already contribute about 80% of oil production from all known enhanced oil recovery (EOR) methods, oil production by thermal recovery is expected to continue to increase for at least 10 years and to provide the highest contribution to oil recovery of all EOR methods for at least 20 years into the future. Under a somewhat more optimistic scenario, oil production from thermal recovery would grow for about 20 years and would continue to produce more oil than any other EOR method for more than 30 years into the future. Thermal oil recovery potential in terms of production rates and ultimate recovery for various technical and economic scenarios are presented in graphical form for the next 30 years.

21316 (CONF-850710–, pp. 55-61) **Heavy versus light oil: Recent changes in refiners perspectives.** Lundberg, T. (Energy Detente, Hollywood, CA (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The two oil price shocks of the 19070s produced wonderful incentives for producers of unconventional petroleum to bring their resources into the market. Oil prices were projected to maintain their new higher levels and the unconventional oils represented an alternative to supplies of conventional oil from unstable regions of the world, particularly the Persian Gulf. Between 1981 and 1984, heavy crudes enjoyed a period of rapid incorporation into the mainstream oil market, bringing unprecedented gains both for heavy oil producers and refiners as well as enhanced supply flexibility worldwide. Since then, however, pressure on the conventional oil market has resulted in the realignment back to light crudes. Even more dramatic, it has encouraged spot trade and soft prices for refined products. As a result, the heavy oil market has reached a plateau. However, the world oil industry has probably come to a point of no return as far as heavy crudes are concerned, with improved refining flexibility provideing enhanced supply security for consumers around the world.

21317 (CONF-850710–, pp. 489-494) **The production of heavy crude oil reduces fuel oil imports in Suriname.** Jharap, S.E. (State Oil Co., Paramaribo (Suriname)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A large number of small developing countries currently obtain their energy requirements from imported petroleum refined products. Up to 50% of their foreign currency earnings is needed to pay

the energy bill. Many of these countries have recently opened their potential petroleum areas for petroleum exploration activities, hoping to find their own petroleum sources. These exploration activities are mostly conducted by multinational oil companies and, in many wildcat holes, small amounts of petroleum have been discovered. These finds, however, do not meet the foreign companies minimum requirements and are therefore abandoned. In some cases the discoveries are deposits of heavy crude at shallow depths. Because of their reduced refining quality these finds are considered to be unimportant. The small oil-importing countries use almost 50% of their imported petroleum products as a fuel oil for industry and/or electricity generation. Many 12°-16°API heavy crudes can be compared favorably with industries Bunker C quality fuel oil. With little processing the produced heavy crude can be a substitute for the imported Bunker C oil. By mixing the crude with small quantities of diesel oil, the viscosity of the crude is lowered and both handling and combustion improve considerably. All treatment and mixing can be done in simple production field installations, and each barrel of heavy crude produced replaces one barrel of imported fuel oil. The technology of drilling and producing heavy crude at shallow depths is such that it can be acquired by nationals in a relatively short period. With limited funds, an oil-importing nation, possessing heavy crude deposits of its own, can start production to replace its fuel oil imports barrel for barrel, and expand production as experience and capital accumulate.

21318 (DOE/BC/14285–1) **Technology transfer to US oil producers: A policy tool to sustain or increase oil production.** Dowd, W.T. Interstate Oil Compact Commission, Oklahoma City, OK (USA). Mar 1990. 140p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88BC14285. Order Number DE90000221. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Department of Energy provided the Interstate Oil Compact Commission with a grant to identify and evaluate existing technology transfer channels to operators, to devise and test improvements or new technology transfer channels and to make recommendations as to how the Department of Energy's oil and gas technology transfer methods could be improved. The IOCC conducted this effort in a series of four tasks: a structural analysis to characterize the oil producing industry according to operator production size class, geographic location, awareness and use of reservoir management technologies, and strategies for adding reserves and replacing produced reserves; targeted interviews conducted with some 300 oil and gas industry participants to identify current technology transfer channels and their relative usefulness for various classes of industry participants; a design and testing phase, in which the IOCC critiqued the current technology transfer structure, based on results of the structural analysis and targeted interviews, and identified several strategies for improvement; and an evaluation of existing state outreach programs to determine whether they might provide a model for development of additional outreach programs in other producing states.

21319 (DOE/EIA–0109(89/12)) **Petroleum Supply Monthly, December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 27 Feb 1990. 153p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90008379. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

Data presented describe the supply and disposition of petroleum products in the United States and major US geographic regions. The data series describe production, imports and exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States (50 States and the District of Columbia). The reporting universe includes those petroleum sectors in "Primary Supply." Included are: petroleum refiners, motor gasoline blenders, operators of natural gas processing plants and fractionators, inter-PAD transporters, importers, and major inventory holders of petroleum products and crude oil. When aggregated, the data reported by these sectors approximately represent the consumption of petroleum products in the United States.

21320 (DOE/EIA–0380(89/12)) **Petroleum Marketing Monthly, December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 12 Mar 1990. 191p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90008528. Available from NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The Petroleum Marketing Monthly (PMM) is designed to give information and statistical data about a variety of crude oils and refined petroleum products. The publication provides statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost of imported crude oil, and the refiners' acquisition cost of crude oil. Sales data for motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane are presented. 12 figs., 55 tabs.

21321 (DOE/EIA–0523(89/3Q)) **International oil and gas exploration and development activities: Quarterly report, third quarter 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 16 Feb 1990. 45p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007493. Available from NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.

This report is part of an ongoing series of quarterly publications that monitors discoveries of oil and natural gas in foreign countries and provides an analysis of the reserve additions that result. It is prepared by the Energy Information Administration (EIA) of the US Department of Energy (DOE) under the Foreign Energy Supply Assessment Program (FESAP). A summary of discoveries and reserve additions that result from recent international exploration and development activities is presented. EIA believes that this information is useful to petroleum industry analysts, various government agencies, and political leaders for the development, implementation, and evaluation of energy policy and legislation. The relationship between oil reserve additions and production for the World, the Organization of Petroleum Exporting Countries (OPEC), Non-OPEC Market Economies (Non-OPEC ME), and Centrally Planned Economies (CPE). 26 refs., 8 figs., 4 tabs.

21322 (ESL–8905772) **Arctic industrial activities compilation. Volume 3, Canadian Beaufort Sea: Seismic and sounding surveys, vessel movements, helicoptor traffic and site-specific activities.** Canadian data report of hydrography and ocean sciences, No. 32. Brouwer, P. (ESL Environmental Sciences Ltd., Sidney, BC (Canada)); McDonald, J.W.; Richardson, W.J.; Davis, R.A. ESL Environmental Sciences Ltd., Sidney, BC (Canada). 1988. 188p. (MICROLOG–89-05772). Available from PC Canada Dept. of Fisheries and Oceans, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Most industrial activities in the Beaufort Sea region are directly or indirectly associated with the search for oil and gas. Activities in marine areas include dredging, drilling, seismic and sounding surveys, island/camp maintenance, vessel movements, helicoptor and fixed-wind flights, and ice-breaking. Information on seismic and sounding surveys, vessel movements, site-specific activities, and helicoptor flights in the Canadian Beaufort Sea from 1980 to 1986 are summarized using maps and graphs. For the 1980-84 period, activities were summarized only for the August 1-September 10 period. For 1985 and 1986, the time frame of the study was expanded to include the period from June 1 to December 31. The level of industrial activities increased yearly from 1980 to 1983, peaked in 1984 and 1985, and then sharply declined in 1986, mainly because of the dramatic drop in the world price of oil. The centre of the main industrial zone remained relatively constant from 1980 to 1986. 15 refs., 34 figs., 2 tabs.

21323 (PRM–CE02870, pp. 22) **Unauthorized cash calls: The curse of frontier projects.** MacMillan, G.S.; Thompson, E.J. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Frontier projects in Canada's oil and gas industry in the late seventies were often made up of partners of widely differing capabilities. The high expectations associated with early exploratory success caused organizations of modest means to commit a large proportion of their risk capital to the exploratory phase in order to maximize their equity in the eventual production phase. Deferment of the production phase caused deferment of the anticipated cash flow from production. This, combined with the increasing cash calls required to continue moving the project forward, made many partners unable to continue to participate in the project. This then tended to lead to breakdowns in the legal side of the documentation that is entered into at the exploration stage. To avoid this hazard, greater attention should be paid to basic planning before technical aspects of the project are considered. A practical guide is provided to evaluate the fiscal risk associated with venturing as a minority working interest owner through the combined use of the execution plan and the joint venture model agreement. A close similarity between frontier projects in Canada and China, centering around the relationship between the project involvement of the provincial (or local) and central governments, is noted in an appendix discussing some experiences with Chinese frontier projects. In another appendix, the practical elements of project management are described, including planning and scheduling, cost control and estimating, material control, labor control, and expediting. 5 refs.

21324 (PRM–CE02870, pp. 13) **Risk management and insurance concerns in frontier exploration.** Gordon, J.M. (J.M. Gordon and Associates Consultants Ltd. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Arctic petroleum companies have been severly affected by poorer quality insurance providing reduced coverage for higher cost. Frontier exploration activity in Canada has been affected to the point where insurance may represent 10% of offshore drilling expense and, in the event of loss, rarely provides the protection expected. Furthermore, regulatory authorities appear to be questioning whether insurance is acceptable financial security for the strict liabilities faced by Arctic operators. The causes and effects of these developments are reviewed, as they specifically apply to the Arctic frontier regions. Long term risk management alternatives to insurance, such as insurance pools, are outlined, and insurance purchasing strategies are suggested to alleviate valuation, cost quality and claims problems. 1 fig.

21325 (PRM–CE02870, pp. 14) **Computer assisted estimating of platform and drilling costs.** Stenning, D.G. (AOE Consultants Ltd., Calgary, AB (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

In order to assist in the planning of a U.S. Beaufort Sea investment strategy, a study was commissioned to develop a rational basis for estimating platform and drilling costs for both exploration and production. In developing this work, a few novel approaches to preparing and presenting cost estimated were developed. This paper discusses the methods and results of the study. The objective of this report was to develop complete well cost estimates for all practical exploration platform alternatives and for 100,000 bbl/d and 200,000 bbl/d production facilities with a single rig satellite drilling structure. Because exploration cost estimates were required to reflect total well costs, drilling and rig move (where applicable) costs were also developed and included in the estimates. Exploration platforms included in the study are ice islands, gravel islands, caisson/berm structures, mobile offshore drilling units, drillships. Production cost estimates included the costs of platform and topside facilities, but excluded crude transportation and drilling costs. Production structures included in the study are steel production platforms, steel satellite drilling structures, and gravel production islands. A computer model became both the database for unit rates and the generator of the cost estimates. The model also generated graphs demonstrating the sensitivity of the cost estimates to various input parameters. 2 figs.

21326 (SASKOIL–03768) **Saskoil annual report 1986.** Saskoil-Saskatchewan Oil and Gas Corp., Regina, SK (Canada). [1987]. 39p. (MICROLOG–87-03768). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

Saskoil is a publicly traded oil and gas company in Saskatchewan that also acts as an oil braker. This documents presents a review of the year's activities, with production-related statistics and financial statements included. Highlights of 1986 include production of 1.4 billion feet cubic of natural gas, a new company record; production of 4.8 million bbl of oil, despite having to shut down 10% of wells which proved uneconomic to operate; a decrease in earnings in a period of falling oil prices, but without any increase in debt; a reduction in staff of 26%; and expanding exploration and development into Alberta. 6 figs., 6 tabs.

0208 Waste Management

Refer also to citation(s) 22611

0209 Environmental Aspects

Refer also to citation(s) 21914, 23246

21327 (EMR–104) **Ice data management systems.** Environmental studies research funds, Report no.104. Terry, B.F. (Compusult Ltd. (Canada)); Lapp, D.J.; Balko, C.L.; Hancock, K.E.; Lapp, P.A. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Department of Indian Affairs and Northern Development, Ottawa, ON (Canada). Jul 1989. 220p. (MICROLOG–90-01183). Available from PC Canada. Environment Canada Water Quality Branch, 1st Floor, Motherwell Bldg.,, 1901 Victoria Avenue, Regina, SK, CAN S4P 3R4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Oil and gas companies engaged in exploration and production drilling off the coast of Newfoundland and Labrador must cope with the seasonal presence of pack ice and icebergs. This task is assisted through ice data management systems. In late 1983, the 3 oil companies planning drilling programs in winter 1984 responded to a set of regulatory guidelines/directives regarding winter drilling on the Grand Banks by establishing a cooperative arrangement known as the Grand Banks Operators' Joint Ice Management Plan. In 1984 and 1985, the plan called for the establishment and operation of a central land-based ice data management system. This study analysed the 1985 system and future ice data management requirements. The downturn in exploration drilling offshore Newfoundland and Labrador which began in 1986 led to the implementation by active drilling companies of a decentralized joint ice data management system. In view of the forecast of a continued low level of drilling activity, it is concluded that the decentralized system is better suited to industry and regulatory requirements. The conceptual design of such a system includes standardization by industry of the specifications each company provides to the contractors who provide data communications services and ice data management system components. It is recommended that a working group be established, to include representatives of the oil industry, industry regulators, ice management contractors and other interested parties, to develop a detailed specification whereby the subsystems in a decentralized system can most efficiently and effectively meet the data management requirements of the Joint Ice Management Plan. 15 figs., 20 tabs.

21328 (IAND–QS-8439-000-EF-A1) **Groundwater resources protection from drilling waste, Northwest Territories and**

Yukon. Environmental studies research fund, Report no.62. Department of Indian Affairs and Northern Development, Ottawa, ON (Canada). Aug 1988. 118p. (MICROLOG–90-00444). Available from PC Indian and Northern Affairs Canada. Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Groundwater is a valuable, renewable natural resource. In the Yukon and Northwest Territories, due to an abundance of surface water and low population density, demand for groundwater is relatively low. Approximately 1600 oil and gas wells have been drilled in the Territories. Each well drilling operation produces substantial volumes of liquid and solid wastes, some of which may have a toxic character. Realization that the northern environment is sensitive to industrial activities have led to a research project assessing potential impacts of drilling waste disposal on groundwater resources. Information collected in the course of this study indicates that drilling waste disposal in sumps, downhole or on land, has not created major environmental damage to date. There are less than 20 documented cases where loss of mud or seepage from a pit has negatively affected groundwater quality within the active layer. Downhole disposal of drilling wastes is not common in northern Canada. Logistical and technical difficulties associated with permafrost and low ambient winter temperatures make this option unattractive. There is no information that would describe a single incident of groundwater contamination originating from either downhole disposal of drilling wastes or improper abandonment of exploration wells. Existing legislation and regulations concerning protection of water resources (including groundwater) against pollution from oil and gas activities appear to be adequate at this time. 94 refs., 2 figs.

21329 (INA/NO–QS-8435-000-EF-A1) **Studies to determine whether the condition of fish from the lower Mackenzie River is related to hydrocarbon exposure.** Environmental studies research fund, report No.61. Lockhart, W.L.; Metner, D.A.; Murray, D.A.J.; Danell, R.W.; Billeck, B.N.; Baron, C.L.; Muir, D.C.G.; Chang-Kue, K. Department of Indian and Northern Affairs, Yukon, YT (Canada). Northern Oil and Gas Action Program. Feb 1989. 92p. (MICROLOG–90-00391). Available from PC Indian and Northern Affairs Canada. Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This report was produced in response to complaints that the quality of fish taken from the Mackenzie River had deteriorated. The investigation focussed on the question of whether pollution from Norman Wells oil could be responsible for the alleged deterioration. Fish taken from the McKenzie river system downstream of the project were compared with fish taken from other sources. Previous investigations had shown that laboratory trout exposed to oil developed discolored livers, high muscel water content, and enzyme abnormalities. The liver biopsies did not show significant differences between McKenzie river fish and other local fish. Size-length relationships expected in fish chronically exposed to oil was not observed in the MacKenzie river fish. One of the most reliable indicators of a response to oil pollution in fish has been the induction of liver microsomal oxidase enzymes; the level of acitivity of these enzymes in fish from Fort Good Hope was not notably higher than in fish from Lake Winnipeg, white fish from the lower Mackenzie drainage were confirmed to have among the highest moisture contents for North American white fish. Fish from the Fort Good Hope and other northern communities were found to contain low levels of seral low-boiling point hydrocarbons present in oil, notably ethylbenzene and the xylenes, especially during winter ice-covered conditions. Polycyclic aromatic hydrocarbons were also identified in some of the fish, but with levels generally inferior or equal to normal. The examination of times indicated no unusual occurrence of metals, but unexpectedly high concentrations of several organochlorines, notably toxaphene. 175 refs., 10 figs., 35 tabs.

21330 (PB–90-856766/XAB) **Oil spill removal: Dispersants, absorbants, booms, and skimmers. March 1978-May 1989 (Citations from the Life Sciences Collection data base). Report for March 1978-May 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 86p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855803.

This bibliography contains citations concerning the techniques available for the removal of oil following major spills. Chemical dispersants, gelling agents, foam plastics, booms, skimmers, and burning are discussed. Specific oil spills are considered and the environmental impacts of oil spills are noted. (This updated bibliography contains 173 citations, 12 of which are new entries to the previous edition.)

21331 (WES–291-PL) **Low cost treatment technology for gasoline contaminated groundwater-Delta, Ontario.** Woeller, R.M (Water and Earth Science Associates Ltd., Carp, ON (Canada)); Devlin, J.F.; Keil, T.R. Water and Earth Science Associates Ltd., Carp, ON (Canada). Jun 1989. 69p. (MICROLOG–90-01033). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This study, funded by the Ontario Ministry of the Environment, provides an assessment of the performance of a relatively low cost, overland flow, biological treatment process to effectively reduce levels of organic compounds in gasoline contaminated groundwater to acceptable concentrations for discharge into surface waters. The remedial work involved the installation of a purge well near the centre of the contaminant plume and its operation at a flow rate of 325 litres/minute. This paper provides details of the construction of the overland flow biological treatment system and an assessment of the performance of the system during the first 12 months of the operation. Benzene concentrations of 100-150 μg/L, toluene at 10-30 μg/L and naphthalene at 30 μg/L were characteristic early concentrations in the purge well effluent. At the treatment system outlet, the contaminant concentrations are generally below laboratory detection levels (1 μg/L). Throughout 1987, the quality of the discharge water remained high and no significant (contaminant related) stress was observed in the treatment vegetation. Thus, preliminary results indicate the system is suitable for long term treatment of gasoline contaminated groundwater. 3 refs., 16 figs., 9 tabs.

0210 Legislation and Regulations

Refer also to citation(s) 21637

21332 (PRM–CE02870, pp. 8) **Canada's frontier lands: A new regulatory direction.** Taschereau, M.E. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-861046–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The Canada Petroleum Resources Act (CPRA) establishes a new regulatory framework for the oil and gas industry in Canada's frontier regions. A major aspect of the CPRA is the issuance of exploration rights. A simple, competitive system has been introduced for the awarding of such rights, based on a single quantifiable biddable criterion, with exploration rights going to the highest bidder. The key factors in determining the single criterion for a particular bid are the geological prospectivity of the lands, and the policy objectives of the province or territory affected. The CPRA requires that land issuance be initiated through a published call for bids that describes the lands in question, the terms and conditions, and the single biddable criterion; in addition, the CPRA states that the terms and conditions of the subsequent exploration license be published with the call for bids, so that all the rules are known in advance. If exploration results in a significant oil or gas discovery, a Significant Discovery License can be issued. This license provides a mechanism whereby an explorer can continue to hold rights to a discovery area while the extent of the discovery is being determined, and, if it has potential for commercial production in the

future, until commercial development is possible. If the economics and technology are sufficiently favorable for commercial production, a production license is issued. Certain options are provided under the CPRA to secure the public interest: a drilling order and a development order.

0220 Transport, Handling, and Storage

Refer also to citation(s) 21932, 22278

21333 (CONF-850710–, pp. 1441-1445) **Heavy crude transportation.** Chand, T. (Oil and Natural Gas Commission, Dehra Dun (India)); Singh, P.J.; Goyal, K.L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Transportation of heavy viscous crudes has been a problem in industry since inception of their exploitation. Methods such as heating and blending had been quite prevalent, but they are expensive and cumbersome. Therefore, attempts have always been made to develop less expensive methods for transportation of such crudes. Emulsification processes for transportation of crudes, though not yet popular and widely adopted, have potential. The method can be used with advantage provided suitable emulsifying chemicals are used. Laboratory studies of emulsification carried out on 17°API viscous heavy crude revealed that with minor dosages of the emulsifying chemicals a reasonably stable emulsion can be formed. The emulsion would break subsequently with an inexpensive treatment over a period of time. Rheology of the formed emulsion is discussed in the paper. The studies are carried out to optimize the transportation mode for a domestic crude oil.

21334 (CONF-850710–, pp. 1447-1454) **Heavy oil transportation: A challenge.** Guilarte, A. (Petroleos de Venezuela (Venezuela)); Rodriguez, W.; Velarde, C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Temblador-Caripito pipeline has a diameter of 30 inches and a length of 145.5 km. It was constructed in 1958 by the Creole Petroleum Corporation (Exxon subsidiary) and the Mene Grande Oil Company (Standard Oil subsidiary) and was designed to transport 60,000 bbl/day of crude oil of 13.5°API with a viscosity of 6600 centipoises at 85°F and a maximum working pressure of 780 psig. This pipeline, laid on the surface without thermal insulation but partially coated, crosses 11 rivers and swampy regions where dense vegetation grows, causing localized severe corrosion that has currently limited the operating pressure to 640 psig. The pipeline has an intermediate booster station located at the Veladero site, 77 km from the Temblador main pumping station. Since 1958, the pipeline has been operating with these two stations, handling a maximum of 55,000 bbl/day of 12.7°API crude oil with a viscosity of 15,000 centipoises at average pressure of 575 psig. Each station is equipped with five screw-type pumps. In mid-1982, a 28 million Btu/hour direct-fired heater was installed at the Veladero booster station in order to maintain the pumping pressure below 640 psig at the Temblador main pumping station. With the operation of this heater at Veladero, the capacity of the pipeline could be increased up to 70,000 bbl/day of 13.5°API crude oil.

21335 (CONF-850710–, pp. 1455-1458) **Heavy oil emulsion treating in Canada.** Kimmel, T.B. (Pengalta Research and Development Ltd., Calgary, Alberta (Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Problems that result when attempting to treat the production from thermally stimulated reservoirs to pipeline specifications are due to the characteristics of the produced fluids and to the inadequacies of the treating facility. This paper is directed towards the Canadian heavy oil emulsion treating experience and reviews the nature of the produced fluids and the methods that are being used in an attempt to meet the Canadian pipeline specifications of 0.5% BS and W.

21336 (NEB-SS–22-1/1989-13) **Reasons for decision [in the matter of] Interprovincial Pipe Line Company, a division of Interhome Energy Inc. A toll design study and recommendations in response to NEB [National Energy Board] reasons for Decision RH-4-89.** National Energy Board, Ottawa, ON (Canada). Nov 1989. V (CE–02903). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

On the 13 June 1989, the Natinal Energy Board advised IPL (Interprovincial Pipe Line Company) and TMPL (Trans Mountain Pipe Line Company) that it had decided to consider IPL's toll design study in the context of the IPL system only, and to proceed with the review by means of written submission. The decisions rendered in November 1989 were as follows: for purposes of IPL's toll design, the Board approves the 5 commodity groups(heavy crude, medium crude, light crude, gasolines and condensates, and natural gas liquids) proposed by IPL. Capacity-related capital and fuel and power cost-considerations shall be intergrated for purposes of surcharge design on the IPL system. The Board approves the use of hypothetical pipeline systems as the base for calculating intergrated capacity(capital) and fuel and power percentage surcharges; furthermore, the intergrated surchages shall be based on long-term pricing considerations, through the use of 20 year life-cycle tolls based on net present value analysis. With exceptions, the Board approves the terminalling charge calculations as proposed by IPL in its study; the inclusion of the costs of cone roofs with those of light crude terminalling is approved: IPL shall calculate a separate delivery tankage charge; IPL's preposed method of calculating and levying terminalling charges is approved. The Board approves the intergration of special facilities and operating costs into the percentage surcharges derived from the optimal pipelines and also approves the discontinuation of the special pools of actual costs. Until otherwise directed, IPL shall update the integrated surcharge calculations every 2 years, or earlier if so requested by the Board or if there are significant changes in the factors which underlie the calculations. 2 refs., 2 tabs.

21337 (PRM–CE02870, pp. 14) **On pipelines for the Arctic offshore and considerations about design, construction and operations.** Fernandez, M.L. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

From operating experience of marine equipment utilized in the Beaufort Sea, from the current understanding of the Arctic environment, and from existing expertise on offshore pipelines, it is reasonable to assume that offshore Arctic pipelines can be safely and economically built and operated. Concerns from regulatory

bodies and economic constraints can be met with proper engineering practice. The main parameters to consider when evaluating or designing pipeline materials and support equipment for Arctic pipelines are remoteness and ice features. During the summer operational period, most open-water construction techniques and equipment may be used for Arctic applications, but ice strengthened hulls or the ability to withstand some ice loading is a desirable feature. The pipe protection approach, including the selection of corresponding construction methods, is of foremost importance. In the Beaufort Sea, selection of techniques and equipment is severely affected by the extensive shallowness of the waters and the varied presence of ice. Activities restricted by shallow waters may be carried out during the optimum winter period, but development and improvement of winter techniques and equipment capable of operating in the winter is needed. The limit state design approach is recommended in order to consider all possible modes of damage including failure, and to define the levels of risk required to analyze all types of loadings form ice features or effects from possible thaw of permafrost. More specifically, the ice-soil-structure interaction approach is applicable to the analysis of the pipeline materials or to the floating support equipment. 5 figs.

21338 (TC/MCI–89-04629) **Report of investigation into the circumstances attending the striking of East Outer Channel light structure number 1, in the American section of Lake Erie by the Canadian tanker "Enerchem Refiner", October 5, 1988.** Investigation report to the Minister pursuant to sections 542 or 545 of the Canada Shipping Act. Transport Canada, Ottawa, ON (Canada). Marine Casualty Investigations. [1989]. 17p. (MICROLOG–89-04629). Available from PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is an investigation of an accident undergone by the Enerchen Refiner, a Canadian tanker engaged in the transportation of petroleum products on the Great Lakes and Saint Lawrence River. At 2125, Eastern Daylight Saving Time, on October 5, 1988, the vessel struck the structure of the number 1 light of the outer channel at the entrance at the entrance of the Detroit River, coming from Lake Erie. She was reversed clear of the structure safely, but had sustained heavy damage to her bow area and inflicted considerable damage to the structure. The costs for repairs are in the order of $1.5 million; there were neither injuries nor pollution as a result of this accident. The report narrates the sequence of events and analyses them from different points of view: environmental conditions, watchkeeping, standing orders, personnel evaluation, radar equipment, events following the collision and damages. The findings of the report are, in particular, that the Enerchem Refiner struck East Outer Channel number 1 light structure at full speed in clear, though dark, conditions, as a results of altering course at the prescribed position. It would appear that the following factors contributed to this accident: lack of communication between the master and the officier on board resulting in a misunderstanding as to who had the conduct of the vessel; failure on the part of the officers to recognize the developing dangerous situation until it was too late; and the officer on board's limited experience in that capacity in confined waters. 8 figs., 1 tab.

21339 (TC/MCI–89-05197) **Report of investigation into the circumstances attending the striking of East Outer Channel light structure number 1, in the American section of Lake Erie by the Candadian tanker "Enerchem Refiner", October 5, 1988.** Investigation report to the Minister pursuant to section 542 or 545 of the Canada Shipping Act. Transport Canada, Ottawa, ON (Canada). Marine Casualty Investigations. [1989]. 17p. (MICROLOG–89-05197). Available from PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is an investigation of the accident of the Canadian oil tanker Enerchem Refiner. At 21:25, Eastern Daylight Saving Time, on October 5, 1988, the vessel struck the structure of the number 1 light of the outer channel at the entrance of the Detroit River, coming from Lake Erie. The vessel was reversed clear of the structure safely, but had sustained heavy damage to the bow area and inflicted considerable damage to the structure. The costs for repairs are in the order of $1.5 million; there were neither injuries nor pollution as a result of this accident. The report narrates the sequence of events and analyses them from different points of view; environmental conditions, watchkeeping, standing orders, personnel evaluation, radar equipment, events following the collision and damages. The findings of the report are, that the Enerchem Refiner struck East Outer Channel number 1 light structure at full speed in clear, though dark, conditions, due to not altering course at the prescribed postion. It would appear that the following factors contributed to this casulaty: lack of communication between the master and the officer-on-board, resulting in a misunderstanding as to who had the conduct of the vessel; fialure on the part of the officers, to recognize the dangerous situation until it was to late, and the officer on board limited experinence in that capacity in confined watrers. 8 figs., 1 tab.

0230 Properties and Composition

Refer also to citation(s) 21185, 21284, 21303, 21427, 21428

21340 (CONF-850710–, pp. 1051-1056) **A thermal classification model for Trinidad crude oils: A thermal analysis approach.** Bartlett, G.W. (Univ. of the West Indies, St. Augustine (Trinidad)); Bruce, P.N. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A total of 20 crude oils taken from separate oil producing reservoirs in Trinidad were analyzed on the Thermogravimetric analyzer. From these analyses two thermograms were produced: the TG thermogram, which registers the weight loss with temperature, and the DTG thermogram, which registers the rate of weight loss with temperature. Characteristic of each crude oil are the maximum rate at which the distillable components undergo evaporation in an atmosphere of air and the percentage by weight of crude sample that undergoes distillation. The former is obtainable from the DTG thermogram and the latter from the TG thermogram. These two parameters may be used for crossplots to classify crude oils in a thermal recovery environment. Coupled with distillation is the quantity of heavy material present in the crude, which relates to both viscosity and gravity of the oil. The general shape of each thermogram may thus be used to compare each crude oil and to aid in the screening process when considering crude oils for the steam flooding process.

21341 (CONF-850710–, pp. 1459-1471) **Transportation of viscous crude oil-in-water emulsions through pipes.** Layrisse, I. (INTEVEP, S.A., Caracas (Venezuela)); Rivero, M.; Paterno, J.; Guevara, E.; Marin, S.; Gonzalez, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The most convenient and usually the most economical method of transporting crude oil overland is by pipeline. In this mode of transportation the power required to move the oil is a direct function of the oil viscosity which, for different crude oils, may vary over a wide range. The flow of viscous crude oils under pipeline conditions tends to be laminar and in this regime the pressure gradient

necessary to move the oil at a given throughput is proportional to the viscosity of the oil; therefore, the pressure gradients in a pipeline transporting high-viscosity crude oil are considerable, and the pumping facilities are larger than those required for transporting low-viscosity crude oil. This increases initial investment and maintenance and operation costs, thereby increasing the cost per barrel transported. The objective of this paper is to present experimental results obtained by transporting oil-in-water emulsions in flow loops with 0.5 and 1 inch pipe diameter both in laminar and turbulent flow conditions. A number of parameters, such as oil content, droplet size distribution, water salinity, and surfactant type have been studied. Mathematical models have been used to predict the emulsion's dynamic behavior at laboratory and field conditions.

21342 (CONF-850710–, pp. 1473-1481) **The preparation of heavy oil-in-water emulsions for transportation purposes.** Taylor, A.S. (BP Research Center, Sunbury-on-Thames (England)); Taylor, S.E.; Murray, E.J.; Chirinos, M.L.; Stockwell, A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Heavy crude oils have been conventionally and successfully transported by reducing their viscosities and hence pressure drops in pipelines either by heating or by the addition of diluents. Where diluents are in short supply and long distances are involved, transportation in the form of oil-in-water emulsions becomes a more economic option. In this study the authors have investigated the emulsification process by drawing comparisons between high shear mixing and low shear mixing and have identified the important factors in each of these processes. It has been shown, in the particular case of viscous oils, that low shear emulsification methods are not only more efficient, but also offer greater control over the physical characteristics of the emulsions produced, in terms of mean droplet size and distribution than high shear mixing. Transportable heavy crude oil emulsions, prepared using low-shear emulsification methods, offer the advantages of increased stability during pipelining because of their low dispersity and narrow droplet-size distributions yet improved resolution characteristics owing to the absence of submicron droplets.

21343 (CONF-850710–, pp. 1483-1496) **Heavy and extra-heavy crude oil-in-water emulsions for transportation: Their formulation, formation, and characterization.** Rivas, H. (INTEVEP, S.A., Caracas (Venezuela)); Chirinos, M.L.; Paz, L.; Layrisse, I.; Murray, E.J.; Stockwell, A.; Taylor, S.E.; Taylor, A.S. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Crude oil-in-water emulsions containing high proportions of crude (~75%) can be formed with relatively low concentrations of surfactants (~3,000 ppm) as stabilizers. Emulsion stability, as well as distribution and mean droplet size, are greatly influenced by the physicochemical composition of the crude oil. Nonionic surfactants and natural surfactants seem to be the most appropriate for the stabilization of crude oil-in-water emulsions. When using nonionic surfactants, and specifically nonyl phenol ethoxylated compounds, the number of ethylene oxide groups per molecule in the surfactant is of paramount importance in finding the optimal hydrophylic-lipophylic balance required for stabilizing emulsions for a given crude. Temperature and aqueous phase salinity modify this optimum balance. Distribution and mean droplet size in crude oil-in-water emulsion, and hence stability, are influenced significantly by the type of mixer and speed and time of mixing used in emulsion preparation. Crude oil-in-water emulsions containing highly dispersed phase volumes (> 70%) behave as pseudoplastic fluids, which obey a Power law equation. For more diluted emulsions, the behavior is Newtonian for the shear rate range studied. Viscosity of crude oil-in-water emulsions is directly influenced by droplet size distribution, but does not depend on the type of oil used.

21344 (CONF-850710–, pp. 1497-1503) **Sizing hot pipelines for the transport of hot emulsified heavy crude oil.** Wirasinghe, E. (Petroleos de Venezuela, Caracas (Venezuela)); Torres, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The transport of heavy oil has always been a difficult problem, and it is further complicated by the presence of produced water. Since the transport system for a heavy oil field development project may account for up to 40% of total cost, design optimization is indispensable. Under isothermal conditions the pressure drop in a pipeline is proportional to flow rate. However, under nonisothermal conditions, the lower the flow rate, the longer the residence time and the greater the temperature reduction of the crude. This results in a drastic rise in viscosity, especially in heavy oils. It is shown that in nonisothermal flow the pressure drop at these low flow rates is the critical design criterion, which is contrary to that in the conventional isothermal flow situation. A computer program, developed and tested in Venezuela to optimize pipeline sizing taking into account this critical aspect is discussed in detail.

21345 (CONF-850710–, pp. 1505-1516) **Transportation of extra heavy crude oils by heating or dilution.** Gonzalez, J. (INTEVEP, S.A., Caracas (Venezuela)); Chirinos, M.L.; Gonzalez, M.; Layrisse, I. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Conventional methods of transportation, heating, and dilution or a combination of these, have the objective of reducing the viscosity of the crude oil to facilitate its transport and treatment. For extra heavy crude oils, the viscosity is, in most cases, at least one order of magnitude higher than that of traditional heavy crudes (12°API). Therefore, a knowledge of how properties like viscosity and density affect these processes is fundamental in the development and optimization of the design of the required facilities, namely, flow lines, pumps, pipelines, heaters, gas separators, dehydration systems, etc. Additionally, the investment involved in transporting these oils represents, most of the time, close to 50% of the total cost of the surface facilities, therefore, it has a tremendous influence on whether exploitation-commercialization projects for extra heavy crude oils are approved. The purpose of this paper is to describe the rheological behavior of extra heavy crude oils and their mixtures with diluents and to present a methodology to optimize the transportation of these oils by heating or dilution.

21346 (CONF-850710–, pp. 1517-1526) **The use of diluents in S.A. MENEVEN's extra heavy crude oil production and transportation operations.** Gonzalez, R.A. (Petroleos de Venezuela, Caracas (Venezuela)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas

(Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The production and transportation scheme by which extra heavy crude is blended with lighter oils as diluent has been successfully used by MENEVEN in its eastern Venezuelan operations for over 20 years. The first application was aimed at reducing the sucker rod failures notoriously frequent in heavy oil operations and was accomplished by placing the lighter oils between the rods and the production string to reduce friction wear and rod flotation on the downward stroke. Subsequently, the lighter oils were pumped down the production string and blended downhole with the extra heavy crude. This application reduced the viscosity of the extra heavy crude, facilitating lifting, treating, and transportation operations, while also reducing rod friction and flotation. Actually, this latter scheme permitted MENEVEN's first large scale exploitation of extra heavy crude in eastern Venezuela, since this product, of very low demand at the time, was converted into a conventional heavy oil that could be transported through existing light oil pipeline networks, avoiding large capital expenditures. This paper describes MENEVEN's current blending operations while pointing out the technical and economic advantages of the scheme. All phases of heavy oil field activity will be covered, from well completion to storage and lifting.

21347 (CONF-850710–, pp. 1527-1535) **Pipelining of heavy crude oils using core annular flow.** Zubillaga, V. (Petroleos de Venezuela, Caracas (Venezuela)); Paterno, J.; Guevara, E.; Romero, T. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The development of the Orinoco Heavy Oil Belt in eastern Venezuela, where average crude oil API gravity is below 10°, requires minimizing of production and transportation costs. As a method to reduce energy consumption and investment in the transportation of very heavy crude oil, the core annular flow technique is being investigated in a field scale testing facility. In the flow mode, the oil in the pipeline is surrounded by a water ring, thus reducing the pressure drop to a value approaching that of water. A review of the theory that supports this transportation mode, the design of the field test loop, the results of the initial tests, and a discussion on the operational aspects of this transportation process are presented.

21348 (CONF-850710–, pp. 1537-1550) **Transportation of Bombay high crude through Salaya-Mathura pipeline system.** Shanbhag, R.A. (Indian Oil Corp., Faridabad (India)); Nicolai, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper deals with the temperature of Bombay High crude through Salaya-Mathura Pipeline (SMPL) system. The SMPL was designed to transport imported crude such as light Arabian or equivalent having low viscosity. After the discover of waxy crude fields in the Bombay offshore, the possibility of transportation of such waxy crude through the existing SMPL has been studied. Bombay High crude (BHC) has a high wax content (15%) and a pour point of about 29°-30°C. As a result, it is difficult to transport the BHC through the existing pipeline, in which the winter temperature can become as low as 16°C.

0250 Combustion

21349 (CONF-850710–, pp. 1553-1568) **Suspension burning of heavy residues and petroleum coke in the limits of environmental standards.** Rodriguez Polanco, D. (INTEVEP, S.A., Caracas (Venezuela)); Jimenez, E.; Grethe, K. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Three fuels, a heavy crude, a vacuum residue, and a delayed petroleum coke were independently fired on an experimental Steinmuller-designed burner. In order to achieve stable ignition of the delayed coke without gas support, high staging levels were required with primary zone stoichiometries ranging from 0.65 to 0.50 being needed. When burner inputs were optimized and the particle distribution of the delayed coke was 90% < 75 μm, burnout levels of up to 96% were measured with a furnace residence time estimated to be about 1.25 seconds. With the liquid fuels, the crude oil and vacuum residue, many combustion aspects were found to be similar, including NO_x and SO_2 emissions, flame temperatures, and radiant heat fluxes, implying that with proper fuels preheat, interchanging these fuels should not present problems. When a proper atomizer and spray angle were used, carbon particulates were found to be low, less than 10 mg/Nm^3. However, due to the high ash contents of these oils, as great as 0.33%, total particulate emissions were often above 100 mg/Nm^3. With both liquid fuels, lowering the excess air level to 10% gave a significant decrease in NO_x emissions without increasing the total particulate loading in the flue gas. Crude oil flames have been directly desulfurized by injection of dry sorbent, $CaCO_3$, $Ca(OH)_2$ and a mixture of Na_2CO_3 and dolomite. The sorbents were injected with high momentum at different axial distances downstream from the burner. Generally, high injection momentum was found to give high sulfur capture rates, up to 55% for $CaCO_3$, (Ca/S = 2), and 90% for $Ca(OH)_2$ (Ca/S = 2).

21350 (EPRI-GS–6714) **Coke formation index: A measure of particulate formation in oil combustion.** Hersh, S. (Electric Power Technologies, Inc., Berkeley, CA (USA)); Giovanni, D.V.; Dryer, F.L. Electric Power Research Inst., Palo Alto, CA (USA); Electric Power Technologies, Inc., Berkeley, CA (USA); Princeton Univ., NJ (USA). School of Engineering and Applied Science. c Feb 1990. 107p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Heavy Oil Combustion research project was initiated in mid-1986 under sponsorship provided by Consolidated Edison Company of New York, The Empire State Electric Energy Research Corporation (ESEERCO), and the Electric Power Research Institute (EPRI). The research is divided into three main work elements that relate to the predictions of particulate matter (PM) and NOx emissions from oil-fired utility boilers: coke (or carbon) formation index (CFI) measurement and instrumentation development; development and design of improved atomization and combustion hardware; and formulation of a mathematical model for predicting carbonaceous particulate matter (PM) and NOx emissions. Electric Power Technologies, Inc. (EPT) is prime contractor and responsible for all aspects of the work. Princeton University is a major subcontractor and is responsible for all laboratory research relating to CFI. The work on atomization is being performed jointly by EPT and Combustion Components Associates, Inc. (CCA), the other major subcontractor in this work. The formulation of the emissions model is being performed by EPT. 89 refs., 31 figs., 7 tabs.

21351 (RMCC/ME–AF-89-02) **Fundamental flammability data for methanol-based spark-ignition engine fuels.** Bardon,

M.F.; Nicks, G.W.; Gauthier, D.; Rao, V.K.; Nijhawran, O.P.; Valvads, R.; Holland, J. Royal Military Coll. of Canada, Kingston, ON (Canada). Dept. of Mechanical Engineering. Sep 1989. 137p. (MICROLOG–89-06301). Available from PC Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The use of methanol and other alternatives to conventional transportation fuels was investigated in a project whose aim was to develop fundamental data related to the distribution and composition of fuel commponents in a spark ignition engine, and to develop analytical techniques for use in other programs such as studies to improve the cold weather starting and running of automotive engines fuelled with various methanol-hydrocarbon blends. The distribution of methanol and hydrocarbon components in the vapour phase was determined experimentally for states consisting of different proportions of liquid and vapour. A new model is proposed for predicting the vapour pressure of methanol blends. It uses a previously developed multi-component volatility model for the gasoline component, pseudo-binary mixing and a modified form of Raoult's Law, corrected for non-ideality. The model predicts M85 (85% methanol, 15% gasoline) vapour pressure and vapour phase composition very well over the temperature range studied experimentally (i.e., 0 to 40 degrees C). It is shown that decreased temperature affects M85 more than gasoline in reducing vapour pressure. In addition, the lean flammability limits were predicted for M85 blends at various stages of evaporation, and verified experimentally. Recommended equations are given for ignition in droplet-vapour-air mixtures under engine conditions. The theoretical analysis suggests that combustion failure under rich heterogeneous conditions is caused by the quenching of propagation, rather than by ignition failure. Rich droplet-laden mixtures can actually be ignited more easily under most circumstances than gaseous stoichiometric ones. 51 refs., 46 figs., 15 tabs.

03 NATURAL GAS

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 21161, 21203

21352 (BCMEMPR–90-00574) **Hydrocarbon and by-product reserves in British Columbia, 1988.** British Columbia Ministry of Energy, Mines and Petroleum Resources, Victoria, BC (Canada). 1988. 328p. (MICROLOG–90-00574). Available from PC , Parliament Bldgs., Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $40.00 CAN; MF $10 CAN.

This report presents the oil, gas, and by-products reserves in British Columbia as of December 31, 1988, as estimated by the Engineering and Operations Branch of the Ministry of Energy, Mines and Petroleum Resources of British Columbia. The year-end remaining established reserves are presented, in both imperial measures and S.I. units. Since a substantial portion of the remaining reserves are in unconnected gas pools, these are separately summarized by plant gathering area. The reserves of oil are 16.6 x 10^6 m^3, those of gas are 256.5 x 10^9 m^3 (raw) and 210.8 x 10^9 m^3 (marketable), and those of by-products are 11.1 x 10^6 m^3 of liquefied petroleum gases, 5.1 x 10^6 m^3 of C_5+ hydrocarbons, and 11.1 x 10^6 tonnes of sulfur. These estimates indicate a 4.6% decline in remaining oil reserves and a 2.8% decline in remaining gas reserves with respect to the previous year. 2 figs., 9 tabs.

21353 (DOE/MC/21181–1950-Vol.12) **Geological evolution and analysis of confirmed or suspected gas hydrate localities: Volume 12, Basin analysis formation and stability of gas hydrates of the Beaufort Sea.** Finley, P.D.; Krason, J. Geoexplorers International, Inc., Denver, CO (USA). Oct 1988. 227p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-84MC21181. Order Number DE90000431. Available from NTIS, PC A13/MF A01 - OSTI.

Geological factors controlling the formation, stability, and distribution of gas hydrates of the Beaufort Sea region were investigated by basin analysis. Geological, geophysical, and geochemical data from the region were assembled and evaluated to determine the relationships of geological environments and gas hydrates. The Beaufort Sea is the southern part of the Arctic Ocean offshore of the North Slope of Alaska and the Yukon and Mackenzie districts of Canada. The Beaufort Sea study region extends northward from the Arctic coasts of Alaska and Canada between Point Barrow on the west to Cape Beaufort on the east. The northern boundary of the Beaufort Sea study region is 72.5°N. The study region comprises broad continental shelves, slopes, rises, and the Arctic abyssal plain. 84 refs., 76 figs., 9 tabs.

21354 (DOE/MC/21181–1950-Vol.14) **Geological evolution and analysis of confirmed or suspected gas hydrate localities: Volume 14, Basin analysis, formation and stability of gas hydrates of the Timor Trough.** Finley, P.D.; Krason, J. Geoexplorers International, Inc., Denver, CO (USA). Oct 1989. 60p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-84MC21181. Order Number DE90000451. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Geological factors controlling the formation, stability, and distribution of gas hydrates in the Timor Trough region were investigated by basin analysis. Geological, geophysical, and geochemical data from the region were assembled and evaluated to determine the relationships of geological environments and gas hydrates. The Timor Trough is located between the Indonesian island of Timor and the northwest margin of Australia. The floor of the Timor Trough is 1800 m to 3400 m deep and ranges in width from 3 to 20 km. The trough extends for about 600 km. The Timor Trough is part of the Banda Arc system; it is bounded to the west by the Java Trench and the Aru Basin to the east. 36 refs., 26 figs., 2 tabs.

21355 (PB–90-132002/XAB) **Analysis of Devonian shale stratigraphic, production, and completion data in West Virginia. Final report, July 1, 1984-July 31, 1988.** Hohn, M.E.; Patchen, D.G.; Behling, M.C.; Timberlake, K.J. West Virginia Geological and Economic Survey, Morgantown, WV (USA). Nov 1988. 71p. Available from NTIS, PC A04/MF A01.

See also PB–87-134086.

The area of historic gas production in southwestern West Virginia has produced gas and minor oil for decades; has thick sequences of black shale; and has relatively broad, low-relief structures that generally trend northeast-to-southwest. The emerging area to the north (Pleasants, Wood, Ritchie, Calhoun, Wirt, and Roane Counties) has experienced appreciable oil in addition to gas production; has many siltstone units interbedded with the Devonian shales; lacks black shale in the eastern counties; and is dominated structurally by a north-south trending anticline that marks the western edge of a detached thrust sheet emplaced from the east. The authors' work has refined and clarified many stratigraphic relationships within the shales and equivalents to the east. On the basis of maps of cumulative production, and the stratigraphic distribution of shows, they concluded that black shales served as a source of gas, some of which migrated into surrounding rocks. In the historic area, where siltstones are rare or absent, some gas migrated to a number of intervals, but most stayed within the black shales. In the emerging area, most gas migrated to siltstone bundles. Although conventional stimulation methods differ marginally in how they affect cumulative production, adjusting for time, shot wells have done better than wells stimulated by the other most commonly used methods.

21356 **Pore water geochemical anomalies: Reliable indicators of gas hydrate presence?.** Finley, P.D. (Geoexplorers International, Inc., Denver, CO (USA)); Dominic, K.L. pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). (CONF-8806307–: Symposium on gas hydrates, Toronto (Canada), 5-10 Jun 1988).

Pore water from sediment cores in which gas hydrates have dissociated should theoretically be enriched in ^{18}O and depleted in Cl^-. Review of geological and geochemical data from DSDP sites in the Middle America Trench region reveals inconsistencies between gas hydrate occurrences predicted from pore water chemistry and documented hydrate recoveries. Modeling of $\delta^{18}O$ enrichment

processes due to hydrate formation does not reproduce measured $\delta^{18}O$ values. Chlorinity and isotope trends at DSDP Sites 496, 497, 568 cannot be ascribed entirely to gas hydrate presence. Site 565 shows no pore water response to proven hydrate presence. Pore water chemical trends are consistent with hydrate recoveries at Site 570. Disseminated hydrate occurrence probably do not cause pore water chemical anomalies greater than those caused by other geological processes. Pore water anomalies are noted where hydrates compose a large fraction of the core volume; however, such hydrate occurrences are detectable by much more direct means.

21357 **Petrographic characterization of hydrate reservoirs in northern Alaska.** Smosna, R.A. (Morgantown Energy Technology Center, WV (USA)); Mroz, T.H. pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). (CONF-8806307–: Symposium on gas hydrates, Toronto (Canada), 5-10 Jun 1988).

The volume of gas that can be produced from a hydrate reservoir depends in part on the rock's porosity. Gas extraction by a thermal drive, for example, may not be successful if the porosity is less than 15%. Petrographic analyses of Cretaceous sandstones from the National Petroleum Reserve in Alaska (NPRA) have identified three major geological controls on porosity – clay content, abundance of ductile minerals, and burial history. On a regional basis, sandstones with the highest porosity (and thus a good hydrate potential) occur in the northern NPRA near Simpson. Sandstones there are clay free, contain a relatively low percentage of ductile grains and have been buried to a minimum depth. Porosity decreases to the south under the influence of these geologic controls; hence, areas in the NPRA away from Simpson have a lower hydrate potential.

21358 **Potential gas hydrate reservoir on the Barrow Arch, Alaska.** Mroz, T.H. (Morgantown Energy Technology Center, WV (USA)). pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). (CONF-8806307–: Symposium on gas hydrates, Toronto (Canada), 5-10 Jun 1988).

This study presents a methodology to define the characteristics of potential hydrate reservoirs in Arctic regions. An evaluation of the Barrow Gas Field area, undertaken to determine if the geologic setting, temperature, and pressure conditions are favorable for the existence of natural gas hydrates, is described. The hydrate stability zone (HSZ) is calculated from temperature gradient data, water chemistry, gas composition, and formation pressure. The HSZ is superimposed on cross section depicting well lithology and compared to available well log responses of resistivity, self potential, sonic velocity, and density to determine if positive indications of hydrates are present. Petroleum chemistry is also examined for each well in an effort to correlate positive hydrate indicators with anomalous gas compositions. The results show that structure I and structure II gas hydrates probably exist in the more porous, shallow sediments in the Barrow area.

21359 **Production of continuous gas hydrates samples: A technology status survey.** Corlett, R.C. (Univ. of Washington, Seattle (USA)); Lawson, W.F.; Dominic, K.L. pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). (CONF-8806307–: Symposium on gas hydrates, Toronto (Canada), 5-10 Jun 1988).

Technology for producing solid samples of gas hydrates is reviewed in the context of measurement needs. Samples of gas hydrates both pure and with dispersed inorganic materials are considered. Discussion is restricted to continuous samples as needed, for example, for thermophysical measurements. Experience to date is reviewed for two basic classes of sample production methods. One is formation of hydrates from pressurized gas on fixed matrices of frost or moist sedimentary matter. The other is the continuous buildup of sample by adding water spray without or with sedimentary matter in a pressurized gas environment. Available information on sample quality as a function of production method and procedural details is presented.

21360 **Mechanical properties of gas hydrates in unconsolidated media.** Siriwardane, H.J. (West Virginia Univ., Morgantown (USA)); Lawson, W.F. pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). (CONF-8806307–: Symposium on gas hydrates, Toronto (Canada), 5-10 Jun 1988).

Under certain conditions of temperature and pressure, a mixture of methane gas and water can form crystalline, ice-like compounds called hydrates. It is believed that large quantities of natural deposits of hydrates are formed in unconsolidated media. Development of recovery techniques of this resource requires comprehensive laboratory investigations on engineering properties of the material. This paper presents a procedure for synthesizing gas hydrates in an unconsolidated sand matrix, and for determining the stress-strain behavior of the material under uniaxial state of stress. Mechanical properties were determined for different porosities, hydrate compositions, and strain-rates. Results from dissociation experiments indicate that the samples prepared according to the developed procedure are homogeneous and suitable for use in investigation on mechanical properties. Based on the results, it can be stated that the mechanical behavior of hydrates is highly strain-rate dependent and that at certain strain-rates the hydrate samples do not exhibit fracture characteristics and behave like dense granular materials.

0303 Drilling, Production, and Processing

Refer also to citation(s) 21203, 21355

21361 (NOIA–89-05124, pp. 55-77) **Concept for conversion of associated gas to methanol.** Tellefsen, T.P. (A/S Uglands Rederi (Norway)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The development of isolated offshore oil fields, early production and extended well testing frequently meets with the problem of utilizing the associated gas. If no pipeline is available for gas export, the gas must either be flared, reinjected or converted to an acceptable energy form, such as electric power, liquified natural gas, or to methanol. This paper describes a completely self contained concept for developing small, isolated, offshore oil fields with associated gas, independent of well head platforms, processing centers or transport pipelines. The main process facilities include gas/oil separation in three separation stages. The stabilized crude from the third stage is transferred to the vessel's crude storage tanks. The gas from the second stage is mixed with the gas from the first stage, resulting in the mixed high pressure gas, which is fed to a methanol plant. Produced methanol is stored in separate tanks. The gas from the third stage is used for fuel purposes. Export of methanol and oil to shuttle tanker is arranged at the aft end of the production vessel. The production vessel is kept in position by a thruster assisted turret mooring system. 4 figs.

21362 (PB–90-132523/XAB) **Hydrologic characterization of coal seams for methane recovery. Final report, January 1987-April 1989.** Koenig, R.A.; Bumb, A.C.; Kunkel, J.R.; McKee, C.R.; Murphy, C.L. In-Situ, Inc., Laramie, WY (USA). Sep 1989. 109p. Available from NTIS, PC A06/MF A01.

See also PB–87-133781.

Coal seams have unique physical and chemical properties that can make conventional production methods for clastic or carbonate reservoirs ineffective. Some dewatering of most coal seams is needed to allow desorption of methane before production can begin. Theory was developed and a well-testing method incorporating the effects of gas desorption and two-phase flow of water and gas is presented to characterize production properties of a coal seam. A well-testing method incorporating the effects of single-phase flow in a vertical well intercepting more than one coal seam was developed to investigate gas production and economic feasibility of multiple, thin coal horizons. A well-testing method was developed to interpret the geometry, size, and effectiveness of hydraulically

created fractures in coal seams, which normally yield complex fractures with vertical and horizontal components. To further enhance the economic potential of a coalbed methane project, personal-computer software was developed to help the operator select a dewatering pump suitable for his particular coal-seam properties and production characteristics.

21363 (PB–90-140997/XAB) **Quarterly review of methane from coal seams Technology. Volume 7, Numbers 1 and 2. October 1989.** Gas Research Inst., Chicago, IL (USA). c 1989. 60p. Available from NTIS, PC A04/MF A01.

Contents include: basin activities–(western Washington, Powder River Basin, Wyoming, Greater Green River Basin, Wyoming and Colorado, Piceance Basin, Colorado, San Juan Basin, Colorado and New Mexico, Raton Basin, Colorado and New Mexico, Black Warrior Basin, Alabama); features–(research in small-scale gas processing, GRI publications on coalbed methane, coalbed methane information sources); methane from coal seams research–(multiple coal seams project, hydrologic characterization of coal seams, spalling and the development of a hydraulic-fracturing strategy for coal, geologic evaluation of critical production parameters for coalbed methane resources, permeability changes resulting from gas desorption); technical events; departments.

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21321, 21323, 21326, 21887, 21927, 21928, 21931

21364 (ANL/EAIS/TM–9) **Penetration of gas delivery systems in the United States: A state-level data analysis.** Guldmann, J.M. (Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div.). Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Feb 1990. 85p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-31109-ENG-38. Order Number DE90007995. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The purpose of this study is to assess the degree to which the gas delivery infrastructure penetrates US regions and states and to pinpoint those areas in which the lack of a sufficient infrastructure impedes the expansion of the natural gas market. Regions and states are ranked according to several indicators developed with data published by the American Gas Association, the US Department of Energy/Energy Information Administration, and the US Bureau of the Census. These include the numbers of gas customers and gas deliveries by sector, mileages of distribution and transmission pipelines, underground storage capacities and operating characteristics, heating degree-days, populations and numbers of households, and areal measures of states and metropolitan areas. The market penetration of gas distribution systems is measured by two indicators: (1) the ratio of the number of residential gas customers to the number of households in 1985 and (2) the distribution pipeline density, measured by the ratio of the 1985 distribution mileage divided by the number of households, while accounting for the effect of urban population density (using earlier econometric results). 11 refs., 1 fig., 27 tabs.

21365 (DOE/EIA–0130(89/12)) **Natural gas monthly, December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 26 Feb 1990. 145p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007868. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

The NGM highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. From time to time, the NGM features articles designed to assist readers in using and interpreting natural gas information. 6 figs., 34 tabs.

21366 (NEB–SS-22-1/1989-14E) **Reasons for decision in the matter of TransCanada Pipelines Ltd. Application pursuant to Part 3 of the National Energy Board Act for a certificate to construct facilities and in the matter of Amoco Canada Petroleum Company Ltd. and Consolidated Edison Company of New York, Inc.,ICG Utilities (Ontario) Ltd.(Gas export and reimport), Indeck Gas Supply Corporation, Western Gas Marketing Limited, West: Volume 1.** National Energy Board, Ottawa, ON (Canada). Dec 1989. 103p. (CE–02931). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

This hearing examined 7 applications for the exportation of natural gas, and one application for the exportation and reimportation of natural gas. The Board used its market-based procedure to judge whether the quantity of gas to be exported did not exceed the surplus remaining after due allowance was made for reasonably foreseeable Canadian requirements, taking account of trends in discovery. The procedure includes an export impact assessment, the gas supply as it relates to reserves and productive capacity, the markets proposed to be served, upstream and downstream transportation arrangements, sales contracts and net benefits to Canada. The Board denied 4 of the gas export licence applications because it was not satisfied that the proposed exports were in the public interest. The Board had varying concerns about each of the applications, including the adequacy of gas supply, the flexibility of contractual arrangements, and the likelihood that the applied-for exports would not generate net benefits to Canada. At the same time, 4 new licences were issued for export of gas to the U. S. and for reimportation of gas. 9 figs., 37 tabs.

21367 (PB–90-130873/XAB) **Gas-cooling markets in the commercial sector.** Brodrick, J.R.; Patel, R. Little (Arthur D.), Inc., Cambridge, MA (USA). Nov 1989. 8p. Available from NTIS, PC A02/MF A01.

A technical/economic assessment of commercial gas-cooling systems relative to electric equipment was performed. The evaluation included assembling data on building cooling loads (building description and weather), utility rates, equipment performance (full and part load), equipment costs, and customer decision criteria; calculating operating cost savings; and developing an analysis program that integrates the factors influencing the competitive advantages of various cooling systems. Trends in the gas-cooling market are discussed along with market and R&D implications.

21368 (PB–90-131244/XAB) **Competitive position of natural gas: Ferrous-metal heat treating and atmosphere generation, February 1988.** Hagler, Bailly and Co., Washington, DC (USA). 1988. 8p. Available from NTIS, PC A02/MF A01.

See also PB–88-187356.

This summary of report GRI-87/0001 provides the results of a study to assess the competitive position and outlook for gas energy and technology use in the ferrous-metal heat-treating market and associated atmosphere generation applications.

21369 (PB–90-132515/XAB) **Competitive position of natural gas: Industrial baking and frying. May 1988.** Gas Research Inst., Chicago, IL (USA). 1988. 8p. (GRI–88/0042.1). Available from NTIS, PC A02/MF A01.

See also PB–88-196381.

The summary of reports GRI-88/0020 and GRI-88/0042 provides the results of studies performed to determine the status of natural gas technologies in the industrial baking and frying markets and to identify R&D to enhance the performance of these technologies. The studies indicate that natural gas will continue to be the most economical energy source for industrial baking and frying.

0308 Environmental Aspects

Refer also to citation(s) 21328, 21914

0310 Legislation and Regulations

Refer also to citation(s) 21332, 21929, 21930

0320 Transport, Handling, and Storage

21370 (CONF-891111–5) **Charge/discharge characteristics of high-capacity methane adsorption storage systems.** Jasionowski, W.J. (Institute of Gas Technology, Chicago, IL (USA)); Tiller, A.J.; Fata, J.A.; Arnold, J.M.; Gauthier, S.W.; Shikari, Y.A. Institute of Gas Technology, Chicago, IL (USA). 1989. 9p. Sponsored by Institute of Gas Technology. From International gas research conference: Tokyo (Japan); 6-9 Nov 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago IL 60616.

The methane storage and delivery are affected by a number of variables. Experimental results and analytical studies show that conditions with low flow rates and high pressures and designs with the cylinder mass that are very large compared to the mass of the adsorbant, enhance storage and delivery. Decreasing the mass of the cylinder, increasing the bed size or bed density, high flow rates, and low charge pressures decrease the storage and delivery. When the mass of the adsorbent bed divided by the mass of the cylinder ≥ 0.3, system behavior changes from isothermal or near isothermal to adiabatic. Utilization of in-situ thermal energy storage (TES) changes system behavior to isothermal and maximizes the utility of the adsorbent system. 1 ref., 6 figs., 3 tabs.

21371 (CONF-8903197–2) **Overview of gas distribution.** Long, G.M. Institute of Gas Technology, Chicago, IL (USA). [1989]. 25p. Sponsored by Institute of Gas Technology. From Symposium on Asian natural gas - a new era; Singapore (Singapore); 6-9 Mar 1989. Available from OSTI - Institute of Gas Technology, 3424 S. State Street, Chicago, IL 60616.

The purpose of this paper is to present a concise overview of the nature of a natural gas distribution utility. To this end, "gas distribution" is defined, then the functions performed while distributing natural gas are discussed. Topics presented include: franchise; planning (layouts, load estimation, sizing, system supply points, and storage considerations); design (codes/standards, materials, corrosion mitigation considerations, valves and fittings, vaults and stations, and main routing); construction (work force, sequencing, testing, purge and tie-in, and setting meters); operations (gas dispatching, customer service,and maintenance); continuity of supply; and sales and marketing. The paper concludes with discussion of converting an existing manufactured gas system over to natural gas. 4 refs., 6 figs.

0330 Properties and Composition

Refer also to citation(s) 21360

21372 (PB–90-130816/XAB) **Chemical activation of methane. Annual report, 1 May 1988-30 April 1989.** Brookhart, M. North Carolina Univ., Chapel Hill, NC (USA). Dept. of Chemistry. 31 May 1989. 39p. Available from NTIS, PC A03/MF A01.

This report describes a strategy for the preparation of transition metal-methane complexes. The complexes have been designed to study coordinatively unsaturated, highly electrophilic transition-metal complexes containing monodentate and bidentate perfluoroalkyl phosphines that are soluble in totally inert perfluoroalkane solvents. The preparation and spectroscopic characterization of several precursor complexes is described. The complexes involve low-valent perfluoroalkyl phosphine derivatives of iron, chromium, and molybdenum. Preliminary experiments indicate a highly reactive, electrophilic sixteen-electron unsaturated species can be generated from the precursor complexes.

21373 (PB–90-131269/XAB) **Oxide-bound transition metal complexes for methane activation. Final report, September 30, 1986-August 31, 1989.** Schwartz, J. Princeton Univ., NJ (USA). Dept. of Chemistry. 16 Oct 1989. 18p. Available from NTIS, PC A03/MF A01.

See also PB–89-138614.

The effect of hydration levels of support oxides on deposition and subsequent activation chemistries was investigated. A series of silicas prepared through different techniques was studied for hydroxyl group concentration and distribution by (1)H NMR. NMR analysis showed that deposition of tris(allyl) rhodium occured on non-hydrogen-bonded OH groups. UHV studies confirmed the nature of covalency between the oxide and the overlayer and demonstrated the participation of oxide oxygens in inter-ligand conversions in the coordination sphere of the attached transition metal. New methodology was developed for directly converting bis(allyl)rhodium or rhodium dihydride complexes to (dioxygen) or (ozone) adducts. The complexes were prepared on alumina, silica, or titania. EXAFS structural data were obtained for several of the complexes. Catalytic oxidation of a test substrate, CO, was done, and rates for oxidation were measured. A flow system for methane oxidation was prepared, and oxidation of methane was examined, either catalytically or stoichiometrically, with the rhodium(dioxygen) species. Only CO2 was obtained. No intermediate level oxidation products were observed, and independent investigations showed that both methanol and formaldehyde were highly reactive substrates toward either catalytic or stoichiometric oxidation procedures. To develop mixed metal systems for methane oxidation, sequential addition of rhodium and molybdenum allyls onto silica was studied. A series of HPA complexes of rhodium was prepared involving both di(carbonyl) and dioxygen adducts. The compounds were studied as soluble models for oxide-based oxidation species.

21374 (PB–90-131996/XAB) **Synthesis for materials for reversible uptake and useful functionalization of methane. Annual report, January-December 1988.** Green, M.L.H. Oxford Univ. (UK). Inorganic Chemistry Lab. Jan 1989. 26p. Available from NTIS, PC A03/MF A01.

See also PB–88-196407.

This report describes such programs in chemistry designed to discover new materials that will reversibly absorb methane gas, or that will act as catalysts for the selective conversion of methane to useful products such as carbon monoxide and dihydrogen, methanol, formaldehyde, or ethylene. Heterogeneous catalysts for selective oxidative coupling of methane to ethylene giving ethylene and ethane are described. Compounds of general formula $Ln_2Sn_2O_7$, where Ln represents the lanthanide elements, are for some of the elements moderately selective towards the formation of ethylene in up to 10% yield. The synthesis of organo-transition metal-intercalation compounds of metal oxides where the metal oxides where the metal oxide lattice is, for example, molybdenum trioxide have been prepared.

0340 Combustion

21375 (PB–90-131251/XAB) **Basic research on radiant burners. Annual report, February 1988-January 1989.** Kendall, R.M.; DesJardin, S.T. Alzeta Corp., Santa Clara, CA (USA). Aug 1989. 44p. (ALZETA–88-727-149). Available from NTIS, PC A03/MF A01.

See also PB–88-220058.

The first year's study demonstrated very close agreement between the radiant burner model predictions and experimentally measured flame liftoff. The second year's study, the subject of the report, focused on flashback of radiant burners. Flashback conditions were identified on a ceramic foam, ceramic-fiber and metal fiber burner with oxygen-enriched combustion air. The results showed that flashback occurred differently for the three burner types with the ceramic fiber burner the least prone to flashback and the ceramic-foam burner the most prone to flashback. Important flashback parameters were identified including the burner material conductivity, porosity, emissivity, and reactivity. The experimentally measured surface temperature and radiation were compared to radiant model predictions to identify when the actual burner performance deviated from the ideal behavior predicted by the model. The third year of the project will focus on measuring and modeling the total radiant output of radiant burner systems including the effects of hot-gas radiation and reverberatory screen radiation.

04 OIL SHALES AND TAR SANDS

21376 (CONF-850710–, pp. 33-47) **The role of oil sands in meeting Canada's future energy needs.** Shaw, B. (Petro-Canada Inc., Calgary, Alberta (Canada)); Ma, S.; Menzies, M.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and

Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper shows how Canada's currently favorable oil supply and demand balance will shift drastically to a shortfall situation in the next decade unless steps are taken to develop supply alternatives to conventional crude oil from Western Canada. It also outlines how development of the nation's oil sands resources, largely located in Northern Alberta, offer the most promising solution to avert this shortfall and indicates the benefits to be gained through this approach to meeting the nation's crude oil requirements.

21377 (PCCIM–CE02873, pp. 40-40.11, Paper 40) **The case for a small oil sands mining project.** Vanderputten, A.G. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

This paper looks at a different approach to the production of bitumen from the surface mineable area of the Athabasca oil sands. A small bitumen project is compared with a large intergrated delevopments in terms of technology, cost, complexity, operability, risk, and capability to promote a sustainable development of the oil sands. It is concluded that most of the available economies of scale in an oil sands complex derive from the upgrader, and that, as a whole, large scale projects do not have a major advantage over small ones. When compared with the routine design of a smaller, more conventional facility, the diseconomies that arise from the prototype nature of an oil sands mega-poject can be appreciable. Operations of small bitumen producer is described as an example. The operation would be designed to produce 30,000 bbl/complete day of a pipelineable bitumen blend product comprised of 67% bitumen and 33% diluent. It would consist of an open-pit truck shovel mine, an in-put truck crusher station with oil sands feed conveyor, a primary extraction plant, a froth treatment plant, diluent recovery, and product handling facilities. It would also require a steam plant for process water heating (fueled by natural gas), a water supply system, and office and maintenance facilities. The operating costs per barrel of produced bitumen should be around $10, with mining and tailings desposal comprising the largest share, at about 65%. The introduction of new technologies into the project is discussed. An oil sands project designed to minimize the intial capital investment is feasible, and should be designed with a mininal project structure and with minimal complexity. 3 figs., 1 tab.

21378 (PCCIM–CE02873, pp. 7.1-7.17, Paper 7) **OSLO [Other Six Leases Operation] project mine planning.** Schmidt, W.H. (Esso Resources Canada Ltd. (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

The OSLO project consists of designing and constructing an integrated oil sands mining, extraction and bitumen upgrading facility in the Athabasca oil sands to the north of Fort MacMurray, Alberta. The project background and schedule are described; the targeted capacity of production in 180,000 tonnes/d of ore and waste, giving 12.500 m^3/d of synthetic crude. The geology of the deposit is described; the oil sands formation is relatively thick, with definite zones characterized by differing ore reject distributions, siltstone concentrations and geothechnical impacts. Contained within the boundaries of the pit are about 153 Mm^3 of bitumens; depending ion the mining equipment and extraction technology chosen, over 80% of this resource is expected to be recovered. The heterogeneity of the deposit leads not only to the challenge of a complicated multi-bench operation, but also to the opportunity to tailor a varied equipment fleet to the characteristics of each part of the ore body. The advantages and disadvantages of dragline and bucket wheel reclaimer, bucket wheel excavators, and shovels and trucks, are compared. The selection of an appropriate mining scheme is critically important; the objective is to achieve the lowest overall capital and operating cost. 9 refs., 7 figs., 2 tabs.

0402 Reserves, Geology, and Exploration

Refer also to citation(s) 21186, 21187, 21188, 21190, 21192, 21194, 21195, 21196, 21197, 21198, 21199, 21206

21379 (CONF-850710–, pp. 85-93) **Use of surface geophysical techniques in oil sands exploration.** Rozenberg, G. (Geo-Physi-Con Co., Ltd., Calgary, Alberta (Canada)); Henderson, J.; Sartorelli, A.N.; Palfreyman, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

It is apparent from the case histories that the described combination of geophysical methods can be successfully applied to a wide variety of exploration objectives in support of surface-mineable oil sand exploration in the Athabasca Basin. The major advantages of the use of geophysical methods are: the detection of anomalous subsurface conditions that subsequently can be investigated by drilling; the ability to monitor the continuity of major boundaries between drill holes; and the optimization of drilling in terms of the integration of the geophysical and geological exploration programs. Seismic and electrical geophysical techniques have proven to be very successful in the Fort McMurray area. This results from the fact that the major geologic boundaries of interest are characterized by appropriate contrasts in either electrical resistivity or acoustic velocity. Experience has shown that no single geophysical method can satisfy the variety of geologic mapping objectives typical for surface mineable oil sands exploration. Rather, a combination of techniques should be used, each of which takes advantage of the particular contrasts in physical properties associated with targeted geologic boundaries.

21380 (CONF-850710–, pp. 107-118) **Oil sands of Sao Paulo state, Brazil and La Brea de Chump, Peru: A geologic perspective.** Kramers, J.W. (Alberta Research Council, Edmonton (Canada)); Roberto Dos Santos, P.; Gianello, P.T. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Oil sands in Sao Paulo State, Brazil, are found in outcrops of the Triassic/Jurassic Piramboia formation. These significant oil sands localities occur on the northern flank of the Ponta Grossa Arch of the Parana Basin of southern Brazil. All the occurrences are found in cross-bedded sandstones of continental origin. Because of the nature of the lithofacies, lateral variations in oil saturation are common. Saturations average 7-8 wt% and range up to 13 wt%. Most oil sands occurrences are associated with faults of diabase dykes, or the flanks of highs in the vicinity of faults or dykes. The source of the oil was probably the bituminous shales of the Permian Irati formation, migrating upward during Lower Cretaceous time along

faults and dyke margins. In the Chumpi area, located in the western belt of the Andes Mountains of southern Peru, oil sands occur in volcanic rocks of the Oligocene Para formation at approximately 3800 m elevation. The oil sands are found in tuffs at several stratigraphic levels in scattered outcrops and 1930s mineworkings. They occur along the crest of an elongated dome, which at one end has been breached by a major fault. At one locality oil is found in the vesicles and fractures of a lava flow. Oil saturations average approximately 4-5 wt% and a maximum of 11 wt% was recorded. The source for the oil is believed to be the underlying marine limestones of late Jurassic to early Cretaceous age. Study of these two nonconventional oil sands occurrences indicates that oil sands are found in widely varying geological situations and that not all oil sands have origins similar to the supergiant conventional deposits of Canada and Venezuela.

21381 (CONF-850710–, pp. 119-133) **Mineralogy and geology of the clearwater reservoir sands in the Wolf Lake area, Cold Lake, Alberta.** Visser, K. (Petro-Canada Inc., Calgary, Alberta (Canada)); Dankers, P.H.M.; Leckie, D.; van der Marel, A.G.P. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Lower Cretaceous Clearwater formation near Wolf Lake, Alberta, consists of an overall upward-coarsening trend overlain by a fining-upward trend. This is interpreted as a regressive sequence followed by a transgressive sequence. The sediments are all marine and there is no evidence of subaerial exposure. Three hydrocarbon reservoirs can be recognized in the Clearwater, of which the lowermost has the greatest potential. This lower reservoir zone is the thickest (average 20 m or 65 ft), richest (up to 14 wt% bitumen), and most continuous in the Wolf Lake area. Calculated porosity values range from 30 to 40%. The interval which represents the regressive sequence can be subdivided into three general depositional facies: (1) offshore; (2) offshore-transitional; and (3) shoreface. This is supported by evidence from the mineralogy and particle size analysis. The mineralogical composition of the lower reservoir sand is litharenitic to feldspathic litharenitic. From base to top the framework mineralogy is constant: approximately 25% quartz, 50% rock fragments, and 25% total feldspar. Rock fragments are mainly metamorphic, but chert and volcanic rock particles are also abundant, especially towards the top of the reservoir. composition and abundance of the pore-space minerals varies: kaolinite is the major clay mineral at the base, whereas chlorite and illite are more abundant at the top. Detrital smectite and mixed-layer illite-smectite are present in variable amounts. Zeolite occurs in very minor quantities.

21382 (CONF-850710–, pp. 909-915) **Geology and mining of Bemolanga tar sands: Physico-chemical studies.** Andrianasolo, H.R. (Office Militaire National pour les Industries Strategiques, Antananarivo (Madagascar)); Raveloson, E.; Rakotosarison, S.; Lalaharisaina, J.V. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Bemolanga oil sand deposit belongs to the uppermost formation in the Malagasy Permo-Triassic Karroo system, the Isalo. The Isalo is a clastic continental formation that crops out in a continuous belt of variable width and extends towards the western sedimentary basin. The best bitumen impregnation is locatted in the Isalo II formation, which is red sandstone sequence with interbedded fine sandstone, clay, and silt. These sandstones, called Bemolanga sandstone, are frequently crossbedded. The upper layer of the Bemolanga sandstone constitutes a reddish to greenish claystone unit and contains some fossils especially ceratodus. The lower part of the formation is dark claystone with lignite and poridera, called base shale, which overlies a very heterogeneous and thick fluviatile sandstone sequence of Isalo I. In order to evaluate the deposit, 236 wells have been drilled. The probable reserves, with an average bitumen content of 5%-7% by weight, with an average thickness of 22.6 meters, are estimated at 340 million tons. The field investigation considers the most adequate surface mining technique to a bucketwheel system for the overburden, drilling-blasting method and dumping the tar sand. The physicochemical properties of tar sand and bitumen suggest that thermal treatment would be the most adequate process to recover and upgrade the oil and minimize the exploitation costs.

21383 (CONF-850710–, pp. 953-962) **Geotomography for exploration of heavy oil deposits.** Singh, R.P. (Indian Institute of Technology, Kampur (India)); Nyland, E. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Seismic and electromagnetic geotomography are useful exploration techniques in heavy oil deposits. They will serve both to delineate reserves and to measure the progress of in situ recovery schemes. The propagation characteristics of electromagnetic and seismic waves for various Athabasca sands can be deduced from laboratory and limited field results. Such results are essential in the proper design and interpretation of exploration projects. For instance, the choice of transmission frequency in EM tomography and the choice of source design in seismic tomography are controlled by the kind of propagation expected in the project. Heavy oil deposits are lossy media. The range of a transmitter signal is also crucial and can be estimated from such results. Once these properties are converted to propagation characteristics it remains to invert the geotomographic data set to obtain structure. The authors suggest the use of an inversion method well known in seismology, but not widely used in industrial geotomography. The Lanczos inverse of the observation equations allows investigation of missing data, resolution of conflicting data, and a clear statement of the significance of the results. It is also known under the name of singular value decomposition. The results from this method can be easily compared with more usual reconstruction techniques such as SIRT and ART.

21384 (PCCIM–CE02873, pp. 5-5.21, Paper 5) **Application of high resolution reflection seismic to surface mineable oil sands.** Henderson, J.D.; Hawes, G.H.; Pesowski, M.S. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

During the last decade, a number of geophysical methods have been successfully used to aid in the exploration and development of surface minable oil sands. It is only more recently that high resolution reflection seismic methods have been applied. This paper presents typical results from a high resolution seismic survey which was included as part of the mine and tailings siting studies during the 1989 winter program for the OSLO Project. The objectives of the reflecting seismic survey are the definition of deep Pleistocene channels, the definition of basal zone stratigraphy, the definition of the Devonian surface and stratigraphy, and the definition of structures within the Cretaceous and Devonian. The results of the

reflection seismic survey show that the method was able to meet the objectives of the surveys. The conclusions of the study are as follows: the technique of combining shallow high resolution reflection seismic and electrical geophysics to target drilling locations, is a cost-effective method of minimizing drilling expenditures; the relatively inexpensive geophysical methods are an excellent way to identify and outline shallow geological structures; the key to the integration of the geophysical methods is a further combination of these methods with control drilling, and interpretation by a team of geologists and geophysicists; and the methods allow for a wider drill hole spacing without sacrificing valuable data accuracy. 7 refs., 12 figs., 3 tabs.

0403 Drilling, Fracturing, and Mining

21385 (CONF-850710–, pp. 671-681) **Oil sands mining and extraction simulation.** Hamel, L. (Petro-Canada, Calgary, Alberta (Canada)); Blake, R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Canster Oil Sands Limited is currently looking at the feasibility of establishing a third surface mining operation in the Athabasca region of northeast Alberta. A computer simulation model (MINEX) of the selected process configuration was performed. The MINEX model features equipment failure and repair distributions, maintenance and operating philosophies, and weather data. Details of the data acquisition, model development, and results to date are discussed in the paper.

21386 (CONF-850710–, pp. 771-789) **Potential use of fracture technology for recovery of bitumen from oil sands.** Chhina, H.S. (Alberta Oil Sands Technology and Research Authority, Calgary (Canada)); Agar, J.G. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Oil sands with high bitumen saturations, although permeable, will not accept steam at reasonable rates below fracture pressure due to the high bitumen viscosity and low connate water saturation. The most common method of achieving a high injectivity is to hydraulically fracture the formation. The resulting recovery processes are dependent on the fracture orientation and geometry (vertical, horizontal, inclined, dish, or chair shaped), the texture of the fracture (i.e., a single fracture or dendritic) and, if vertical, the fracture trend. The characteristics of the fracture obtained are highly dependent on the in situ stresses which, in turn, are influenced by factors such as tectonic forces, previous fractures, pressure variations, and heating. Fractures are also affected to some extent by the fracturing technique, although the degree to which this is true is highly controversial. This paper examines the native and modified in situ stresses found in some Alberta oil sands deposits and reviews fracturing experience in Alberta as it relates to theories of hydraulic fracturing.

21387 (CONF-850710–, pp. 791-796) **Downhole hydraulic mining system.** Wagner, C.G. (California Tar Sands Development Corp., Orange (USA)); Hodges, E.L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Certain tar sand deposits in Canada, Venezuela, and the US occur at depths from 100 to 600 feet. The deposits contain more than 150 billion barrels of bitumen that cannot be produced using such current technologies as open-pit or subsurface mining or heat-assisted in situ processes because these technologies are inefficient, environmentally incompatible, or economically not feasible. The downhole hydraulic mining system was specifically developed to exploit these tar sand deposits. Initially a borehole is drilled through the tar sand and the system mining sections, consisting of a cutting-jet nozzle module and a jet pump module, are lowered to the tar sand. High-pressure water jets impact and erode the sand, creating a sand/water slurry, which is pumped to the surface through the sections of the tool. At the surface, bitumen can be separated from waste materials. The waste rock is reinjected into a mined-out cavern and the water recycled into the mining system. Disturbance to the land surface is minimal. Mining rates of up to 315 tons of ore per hour have been demonstrated in field tests. The hydraulic mining system has several inherent advantages: minimal environmental impact; application to deposits too deep to strip mine and too shallow to heat; high percentage of oil recovered from in place reserves; high mobility of system; low sensitivity to overburden/ore ratios.

21388 (CONF-850710–, pp. 891-899) **Technological advances in oil sand development in syncrude.** Adam, D.G. (Syncrude Canada Ltd., Edmonton, Alberta (Canada)); Hyndman, A.W.; Lesko, G.L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Syncrude Canada Limited began operation of its oil sands plant in the Athabasca oil sands region of northeast Alberta, Canada, in 1978. The operations involve open pit mining of the oil sands, extraction of the bitumen from the sand, and upgrading of the bitumen into synthetic crude. Plants and operations were designed on the basis of technology available and proven in 1974, to produce 40×10^6 barrels of synthetic crude oil per year. Mining is carried out by dragline excavation, bucketwheel reclaiming, and conveyor transport. Bitumen is extracted from the sand by the hot water process and upgraded by fluid coking followed by hydrotreating of the coker products. Syncrude has developed or introduced new technology since the original plant start-up, which has improved the efficiency, resource utilization, and environmental performance of the original plant. The implemented or planned innovations include better geological definitions of the ore body, new mining approaches, advances in the hot water extraction process, and new upgrading technology. Technological advances have also resulted in improved environmental performance by increased sulfur recovery and reduced losses of hydrocarbons to the tailings pond.

21389 (PCCIM–CE02873) **Mining and energy challenges.** Petroleum Society of CIM (Canada). 1989. vp. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

This meeting deals with exploration and mining, mainly of coal and of oil sands, with mine organization, planning and equipment, with the disposal of mine tailings, and with land reclamation. Other topics covered are waste heat utilization in mines, power plants for

mining applications, the enhanced recovery of petroleum, and human resources management. The main focus is on the Province of Alberta. Separate abstracts have been prepared for 24 papers.

21390 (PCCIM–CE02873, pp. 1-18, Paper 39) **Implementation of reliability concepts at Syncrude's Mining Department.** Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

The Syncrude Canada Limited mine situated north of Fort MacMurray, Alberta, has been in continuous production from a surface oil sand deposit since 1978. The present level of production is of 300,000 tonnes/d of oil sand moved, utilizing draglines, bucketwheels and conveyors. In addition, 220,000 tonnes/d of waste overburden is handled by a large truck/shovel fleet. In order to increase the operating time of the existing equipment, a reliability program was undertaken along the following principles: predictive maintenance, based in the monitoring of equipment condition; proaction rather than reaction; analysis of failures to determine their root causes; and utilization of timely, accurate information for decision-making. The paper discusses the concepts of reliability: organizational focus, information systems, and the prediction, analysis and avoidance of failures. The implementation of these concepts is based on data management, analytical services, mine inspections, and maintenance engineering. A crucial factor in ensuring the success of the new Reliability Division was leadership. The mean time between failures of 395-B electric shovels was increased by 12%, the production efficiency of heavy haulers was increased by 4%, and the mean time to repair heavy haulers was decreased by 7%. Human reliability will be the focus of future reliability work at Syncrude. 2 refs., 14 fig.

21391 (PCCIM–CE02873, pp. 1-16, Paper 37) **AOSTRA [Alberta Oil Sands Technology and Research Authority] underground test facility progress and potential.** Haston, J.A. (Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada)); Luhning, R.W.; Gittins, S.D. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

The Underground Test Facility project operated by the Alberta Oil Sands Technology and Research Authority north of Fort McMurray has achieved marked success in field-testing the mining access and horizontal well in-situ recovery of bitumen from the Athabasca oil sands. Mine access has provided for the effective placing and operation of horizontal wells in the oil sands from a tunnel system in the underlying limestone. The performance of the in-situ recovery process, steam assisted gravity drainage, has substantially exceeded the forecasts made at the start of the projet. The overall results of the program to date show great promise for horizontal well in-situ technology as a competitive source of bitumen from Alberta's oil sands deposits. The potential economics of a commercial expansion at the site are reviewed in the paper, and are found to be highly competitive, with a cost of $68.60/m3 of bitumen recovered, comprising $13.15 for mining and drilling, $14.91 for processing, $21.72 for operations and maintenance, and $18.81 for fuel consumption.

21392 (PCCIM–CE02873, pp. 1-11, Paper 25) **OSLO [Other Six Leases Operation] project.** Lynn. J. R., (OSLO Project, (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

The OSLO is currently the largest energy project under development in Western Canada. With an early cost estimate of $4.5 billion, and a target of producing 78,000 bbl/d in 1997, the project team has to plan for the most efficient mineable oil sands project yet to be built. The project was set up to focus on the good quality surface mineable deposit identified as existing on the lease number 31m, 60km north-east of Fort MacMurray. The project should be more successful than the previous ones of the same nature because of the acquired experience and because of the emphasis on intergrated design; it is expected that a 30% efficency increase over existing operations can be achieved. Only commercially proven technology will be utilized; new techologies will be incorporated after they will have been proven on a commercial scale. The project involves conventional surface mining techniques to strip the overburden and mine the oil sands. Bitumen will be extracted from the sands by an improved hot water process fed to an upgrader. Using state of the art hydrogenation technology, the upgrader will convert the bitumen into high quality synthetic crude oil that will be a suitable feedstock for Canadian and American refineries. A risk assessment study is being done. A mobile mining scheme appears to be marginally better than a countinuous mining scheme. To assess the effectiveness of the chosen extraction technology on the specific ore, a bulk sampling pit has been constucted on the project site and a pilot plant, in Calgary. Waste management and the environmental effects of upgrading are outlined. The discussions with the stakeholders and the project schedule are presented. 1 refs., 2 figs.

21393 (PCCIM–CE02873, pp. 10-10.22, Paper 10) **Application of conveyor belt monitoring technology to conveyor belt reliability.** Barton, J.L. (Syncrude Canada Ltd. (Canada)); Murray, R.A. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

This paper looks at how Syncrude Canada Ltd. is utilizing the Conveyor Belt Monitoring technology developed and patented by the Australian CSIRO (Commonwealth Scientific and Industrial Research Organization) and licensed to Syncrude by Conveyor Belt Monitoring (SCBM) of North America, Inc. The technology involves magnetizing the steel cables in the conveyor belt and detecting the fields produced by breaks, gaps or cable ends using special sensor which feed the signals into a multi-channel recorder to provide permanent traces of the various events taking place in the steel cable belt. The data are analyzed and combined with existing belt audit programs, to assist in predicting belt life, change-out criteria and belt design, loading and construction. The application of the CBM technology forms an integral part of the conveying system reliability program. One of the major limitations of the CBM technology as applied to the Syncrude site is that it does not address the single biggest threat for a major downgrading incident to the conveying system, that of ripped belts occurring between the cables. This is the major weakness of the steel cable construction and the most common reason for the replacement of conveyor belts in the mine; however, other technologies have been developed to address this problem. The application of the CBM technology to the extraction plant is proven and, in the mine, it is still improving, but the ultimate goal is that the technology will eventually take its place with the other recent tools of technology, ultrasonic scanning, vibration analysis, in providing the raw data to make educated decisions in the safe and reliable operation of the Syncrude plants. 15 refs., 15 figs., 3 tabs.

21394 (PCCIM–CE02873, pp. 36.1-36.16, Paper 36) **Development of a borehole hydraulic mining method for the OSLO [Other Six Leases Operation] shallow oil sands deposits.** To, N.M. (Esso Resources Canada Ltd. (Canada)); Dunn, E.J. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada,

555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

A significant proportion of Athabasca oil sands deposits is under 100m or more of overburden. These deposits are uneconomical to mine using currently available mining methods. As operator of the Other Six Leases Operation (OSLO), Esso Resources Canada Limited has been developing the borehole hydraulic mining method for the shallow resources in the OSLO lease area. This mining method involves accessing the oil sands through a pre-drilled borehole and cutting the oil sands with a high pressure water jet directed from a mining tool which is lowered into the borehole. The resulting, oil sands slurry is pumped to the surface to be processed; an alternative technique to process the slurry in the cavity developed. Oil sands removed from the cavity can be replaced in the mined-out cavity so that minimum reclaimation needs to be done. The advantages and disadvantages of the borehole hydraulic mining method are presented and the system is described. Tests indicate that oil sands can be cut with high pressure water jets, that the system is economically feasible, and that the water jet pressure(threshold pressure) required to cut in-situ oil sands is much lower for cutting under water than for cutting 9 refs., 6 figs.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 21211, 21212, 21216, 21217, 21218, 21221, 21222, 21223, 21224, 21237, 21238, 21239, 21243, 21244, 21248, 21251, 21253, 21254, 21255, 21256, 21257, 21258, 21259, 21260, 21261, 21262, 21263, 21264, 21265, 21266, 21267, 21268, 21269, 21270, 21271, 21272, 21273, 21274, 21275, 21276, 21277, 21278, 21279, 21382, 21385, 21387, 21388

21395 (CONF-850710–, pp. 95-105) **New analytical results on oil sands from deposits throughout the world.** Wallace, D. (Alberta Research Council, Edmonton (Canada)); Carrigy, M.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Analytical data describing the bitumen and water-soluble salts in 19 oil sands deposits demonstrate the need for well-planned strategies for sampling and sample-storage. The variability in properties of bitumen and water-soluble salts in several cores shows that coring over the vertical depth is a prerequisite to obtaining representative analytical data. Storage of oil sands at ambient temperatures after exposure to oxygen can seriously affect the separation of bitumen from oil sand. The analyses carried out in these preliminary evaluations are useful in assessing potential recovery methods and upgrading characteristics for the bitumen. The information, however, lacks the detail required to classify the bitumens by a single general classification scheme.

21396 (CONF-850710–, pp. 441-452) **Mud systems and solids control at Wolf Lake.** Markiw, I.A. (BP Canada, Calgary, Alberta (Canada)); Tarlton, J.T. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The BP-Petro-Canada Wolf Lake Project involves the construction and operation of facilities for the production of bitumen from BPs Marguerite Lake leases. The initial 192 wells at Wolf Lake were predominantly drilled with KCl mud. However, Gel-Chem mud was tested on several pads in order to compare its cost and performance with KCl mud, and to determine the mud system best suited for future oil sands development projects in the Wolf Lake area. Optimization of the mud system is closely related to optimization of the solids control equipment, and both directly influence the rate of penetration, volume of mud disposal to the sumps, disposal cost, and ultimately wear on equipment. This paper offers a cost and technical comparison of mud sysems at Wolf Lake, and recommendations for improved solids control for future oil sands development projects.

21397 (CONF-850710–, pp. 513-522) **Evaluation of the P2-3 sand in situ combustion project in the Miga field of eastern Venezuela.** Cordero, F.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In 1964, Mene Grande Oil Company (now S.A. MENEVEN) started a fireflood in the P2-3 sand, MG-517 reservoir, in the Miga field of eastern Venezuela. Since that time, the project has continued and approximately 50 billion scf of air has been injected. The overall cumulative air-oil ratio (AOR) has been about 12,000 scf/bbl. The original oil in place has been estimated at 19.2 million barrels of this, 5.2 million barrels, or 27.1%, has been recovered, of which 4 million is the secondary oil attributed to combustion and 1.2 million is the estimated ultimate primary production. The present study was undertaken to evaluate the fireflood performance and more particularly to determine the future course of action. The study indicated that at least 3349 acre-feet of reservoir is still available for burning. It was estimated that 1.7 million barrels of oil can be recovered from this unburned section, requiring additional 25 billion scf of air injection. However, to exploit this remaining oil, efforts should be directed toward increasing the air rate in well MG-825, since it has been observed that the present air injection rate may not be sufficient to propagate a high temperature burning front through the reservoir. It is believed that the reservoir is presently being heated by a low temperature oxidation mechanism. From pressure fall-off tests in well MG-825, the burned volume around this well was estimated to be 1604 acre-feet. Also, it was calculated that the firefront is at a radius of 1217 feet from well MG-825, assuming a radial configuration.

21398 (CONF-850710–, pp. 697-713) **The ENPEX project: System design and economic analysis of an integrated tar sands production and upgrading project.** Hertzberg, R.H. (ENPEX Corp., San Diego, CA (USA)); Hojabri, F. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

During the period 1980-1985, the ENPEX Corporation has undertaken the development of the San Miguel tar sands in south Texas. This huge, untapped hydrocarbon resource requires the implementation of an integrated production and upgrading system that can produce the heavy tar (−2°API) and convert it at high rate to gasoline, jet fuel, diesel, and residual oil. ENPEX's work has included the evaluation of several steam-raising technologies, including fluidized bed coal/coke combustion, coal gasification, gas fired and oil fired steam generators, and high temperature gas cooled reactors; the evaluation of 12 upgrading systems; upgrading pilot tests on produced crude; the design of integrated systems for the production and upgrading of 5,700 b/d-20,000 b/d tar; and the

design construction, and operation of a 400 b/d tar production facility based on the use of fluidized bed coal/coke combustion. This paper provides major findings of the work to date.

21399 (CONF-850710–, pp. 715-719) **Pilot plant test of the Taciuk process on oil sands from Madagascar.** Werth, F.J. (Alberta Oil Sands Technology and Research Authority, Edmonton (Canada)); Caple, N.R.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Tacium process is a dry, retorting process developed for the recovery of hydrocarbons from mined oil sands. Successful pilot plant testing at 5 Mg/h, using Athabasca oil sand, has established the technical feasibility of the process, and a large 90 Mg/h demonstration test is now under consideration. Test results on Athabasca oil sands suggested that the process will be applicable to oil sands from other deposits. In 1984, the Taciuk process was successfully tested on oil sands from the Bemolanga deposit in Madagascar. A 550 Mg sample was processed in a pilot plant to produce a light weight, low sulfur content product oil. Hydrocarbon recovery of 0.7 mass fraction produced liquid yields of up to 59 L/Mg of feed. This paper provides a description of the Taciuk process, events leading to the test on Bemolanga oil sand, commentary on the pilot runs, and the results from the tests.

21400 (CONF-850710–, pp. 721-730) **Recovery of bitumen from tar sands by a thermally coupled fluidized-bed process.** Seader, J.D. (Univ. of Utah, Salt Lake City (USA)); Smart, L.M. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. DOE Contract FG01-82CE15136. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A scaled-up replacement of a two-staged fluidized-bed reactor, for the thermal processing of tar sands, has been constructed, tested, and successfully operated over a range of operating conditions. The 4.25-inch-diameter reactors contain three liquid-metal heat pipes, with potassium as the working fluid, which function to transfer all the energy needed to maintain the upper-bed temperature and to pyrolyze the bitumen.

21401 (CONF-850710–, pp. 731-737) **The Herter solvent extraction process for the recovery of heavy oils and tars.** Babcock, R.E. (Univ. of Arkansas, Fayetteville (USA)); Daniel, R.D.; Herter, G.L. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The Herter process is technically feasible and a viable alternative in the recovery of heavy oil and tar from tar sands. Bench-scale data indicate that fatty acids (pure oleic and commercial grades) have sufficient solvation capacity and viscosity-reduction properties to achieve successful extraction efficiency. The saponification reaction is immediate. the desaponification reaction is less rapid, but sufficient to achieve reconstitution of the fatty acid. The overall economic feasibility of the Herter process warrants further study. The three key variables are the solvation capacity of fatty acid on site-specific tar sand; the control of emulsion formation in the saponification reactor; and the price of tar or asphalt. The process appears to be competitive with other solvent-extraction processes because of the current relatively low cost of commercial fatty acids (19-20¢/lb) and the low energy utilization of the separation process. Research is continuing on all aspects of the Herter process at the Department of Chemical Engineering at the University of Arkansas.

21402 (CONF-850710–, pp. 739-747) **A new extraction technology for tar sand production.** Sadeghi, M.A. (Univ. of Southern California, Los Angeles (USA)); Kuo, J.F.; Yen, T.F.; Jang, L.K.; Sadeghi, K.; Palmer, R.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A low temperature, ambient-atmosphere, closed-system process, combining upgrading with extraction in one step for bitumen recovery, has been developed. The bitumen so far recovered is extremely low in ash content, virtually free of metals and asphaltene, with an average gravity of 15°API and a 95% cumulative recovery (based on carbon content) in a continuous operation. The heavier fractions, asphaltene and preasphaltene, were separated as solids in which many high-enriched strategic metals were found. Simultaneously, clean sand and intact clay can be easily and recovered essentially in full. The process utilizes the principle of membrane-mimetic chemistry in which a selective cation (e.g., sodium, potassium) reacts with the acid-bearing functional group from the bitumen to develop a host-guest cavity in a cylindrical shape. The outer counter ions are activated to allow the inorganic to dissolve within the organic phase to produce a surfactant. with the application of energy at a low radio frequency, the multilamellar vesicles are dissociated into individual micelles, which can be reorganized into the oil phase. In this manner, the lighter portion of the bitumen (hydrocarbons) can be separated from the heavy residua (asphaltics). A preliminary bench-scale model has been evaluated and economic analysis has revealed that this process is very attractive.

21403 (CONF-850710–, pp. 749-760) **Processing of Athabasca oil sands by agglomeration and solvent extraction.** Hoefele, E.O. (Petro-Canada Inc., Calgary, Alberta (Canada)); Hamilton, J.F.; Filby, J.E. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper describes experiments carried out by Petro-Canada to test the NRC SESA process with a wide range of oil sand grades. Using a modified SESA process, water was added as a binding agent for the clays, and the oil sands were extracted with naphtha; the agglomerates settled quickly and were easily separated from the bitumen-rich solution. The coarse sand and clay agglomerates, coated and impregnated with bitumen solution, were washed with naphtha solvent. The granular solids bed allowed fast draining. The extracted sand, which was subsequently sent to a steam-stripping stage for solvent recovery, had a naphtha content of 5 to 11 wt%, and a very low residual bitumen concentration of 0.2-0.5 wt%. The bitumen ranged from 92-96% for low grade ores to 95-97% for medium and high grade ores. The product stream was a bitumen in naphtha solution ranging between 10 and 30 wt% bitumen. Solids content of the product stream could be controlled by the agglomeration and settling conditions.The extracted

sand was steam stripped in a rotary tumbler. Residual naphtha contents of less than 1000 ppm, in the tailings stream, were attainable. The results of these experiments demonstrate that proper agglomeration of fine clays enables a solvent extraction scheme to successfully process a wide range of oil sand ore grades. They also show that steam stripping is a feasible method of recovering naphtha from extracted sand.

21404 (CONF-850710–, pp. 797-804) **In situ RF heating for oil sand and heavy oil deposits.** Briggs, J.E. (IIT Research Institute, Chicago, IL (USA)); Sresty, G.C.; Dev, H. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In situ recovery technologies for tar sand and heavy oil are simulated at the Western Research Institute to prepare for pilot tests and commercial operations. Wide ranges of process parameters are tested in one-dimensional reactor tubes in which the tar sand or heavy oil is uniformly reconstituted to nearly the same permeability and porosity as the field resource. Three-dimensional process performance is verified in a reactor system that demonstrates the most promising operating parameters in consolidated blocks of the field resource. Both of these reactors are capable of testing combustion or steamflood processes at pressures as high as 1000 psi. Initial laboratory simulations have tested steam flooding of Asphalt Ridge tar sand for comparison with previous results from a pilot test near Vernal, Utah. Oil production rates, properties, and residual saturations have been measured for different operating conditions, reservoir properties, and bitumen concentrations. Corresponding operating parameters and production performance are compared to evaluate the relationships between the laboratory simulations and the field test results. These comparisons show that the residual oil saturations and sweep efficiencies in the laboratory tests are similar to the results of the field tests.

21405 (CONF-850710–, pp. 813-827) **Laboratory comparison of steam recovery experiments using preserved oil sand cores.** Gibson, B.J. (Petro-Canada Production Research and Development, Calgary, Alberta (Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Between 1976 and 1982 an extensive lease evaluation program was undertaken in the Athabasca oil sands of Alberta, Canada by Petro-Canada, on behalf of the PCEJ lease owners (Petro-Canada; Canada-Cities Service, now Canadian Occidental; Esso Resources Canada Ltd.; and Japan Canada Oil Sands Ltd.). A separate evaluation program was also done in the nearby Primrose-Kirby area (100% Petro-Canada holdings). Oil contained in these lands is located from 100 to 500 m deep and, therefore, must be recovered by in situ techniques. It is recognized that the success of these recovery methods is affected by reservoir heterogeneities caused by geological processes during deposition. A laboratory study was therefore undertaken, which compared and evaluated bitumen recovery from preserved cores with lithological and facies differences. This paper discusses the impact of core matrix and fluid properties such as grain size, grain sorting, clay content, and oil viscosity upon oil recovery using a laboratory cyclic steam stimulation process. X-raying of core samples through plastic core tubes was necessary to select and describe core sections prior to experimentation. Homogeneous, fine grained samples, in which shale or clay laminations were absent and that also had low clay content and moderate sorting, produced the greatest amount of oil. Poorly sorted, bioturbated cores with larger clay fractions produced the least quantity of oil. The presence of fine cross laminations or parallel laminations of interbedded sand and shale lowered the effectiveness of the steam recovery process. Higher oil viscosity had little effect on reducing oil recovery within the range of these experiments. Petrographic data as well as net pay are important criteria to consider when choosing field locations for in situ recovery methods.

21406 (CONF-850710–, pp. 829-835) **Factors affecting producibility of oil sands by steam stimulation.** Khosla, A. (Petro-Canada, Calgary, Alberta (Canada)); Qureshi, F.; Khosla, A.; Qureshi, F. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper discusses factors relating to the wells and reservoirs that affect the production performance for steam stimulation of oil sands. The analyses can be used as a guide to extrapolate or interpret the results of pilots for commercialization. As a first step, the one-well-test physical characteristics of the Primrose-Wabiskaw reservoir were history-matched by computer modeling the field performance. Subsequently, production field strategies were optimized over 2 years of pilot operations by analyzing the effect of the following factors along with the operational parameters: (a) slug size, (b) injection rates and pressures, (c) soak periods, (d) production cycle length, (e) perforation intervals, (f) interwell communication, and (g) pattern configuration size and well spacing. Computer model studies were used to develop field operating strategies. Field results in turn were used to modify the computer model. This ensured that the correlations developed were realistic as well as reliable.

21407 (CONF-850710–, pp. 847-861) **An oil sands oxygen in situ combustion project.** Donnelly, J.K. (BP Resources Canada Ltd., Calgary, Alberta (Canada)); Hallam, R.J.; Duckett, J.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

BP Resources Canada Limited is operating an oxygen in situ combustion pilot at Marguerite Lake, part of the Cold Lake oil sands deposit in eastern Alberta. The pilot consists of two principal areas: a three well, wet air combustion test and an infill-drilled, four five-spot, wet oxygen combustion project originally on two-hectare spacing. Prior to converting the project to combustion, it was operated on cyclic steam to provide data to justify and design a commercial project. This project is the 1,100 m^3/d Wolf Lake project, which started production in April 1985. The three well, wet air combustion test was conducted to obtain operating experience prior to introducing combustion into the main pattern of the project. The test was operated successfully and lasted from 1979 to 1984. During 1981 a feasibility study was conducted, which concluded that oxygen rather than air should be used in the main pattern and that a mechanical test of an oxygen injector should be carried out before complete conversion of the project to combustion. In March 1983, enriched air was introduced into well EX-4 in the main pattern of the project and by May 1983 injection of high-purity oxygen had been achieved. The test was successfully ended in October 1983. Following the EX-4 test, three more wells were converted to oxygen injectors and the project operated an additional one and

one-half years. In spite of some operating problems the initial results of the pilot have been sufficiently encouraging to warrant extending its life and to plan the incorporation of combustion in the Wolf Lake project in the early 1990s.

21408 (CONF-850710–, pp. 901-908) **Progress report on the construction of an underground test facility in the Athabasca deposit, Alberta, Canada.** Carrigy, M.A. (Alberta Oil Sands Technology and Research Authority, Edmonton (Canada)); Stephenson, H.G. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Since 1975, the Alberta Oil Sands Technology and Research Authority (AOSTRA) has been investigating many methods of recovery bitumen from the vast reservoirs of oil sands in Alberta. In the late 1970s, AOSTRA began to investigate the use of horizontal or semihorizontal wells drilled, not from the surface, but from tunnels contructed either in the vincinity of the reservoir or even with in the pay zone. The idea is know as the Shaft and Tunnel Access Concept (SATAC). The Underground Test Facility will provide operators with the opportunity to conduct in situ process testing and bitumen recovery schemes.

21409 (CONF-850710–, pp. 917-932) **Design and development of thermal pilots for recovery of heavy oil from the tar sands of the Ras Gharib field, Gulf of Suez, Egypt.** El Dewake, H. (General Petroleum Co., Cairo (Egypt)); Mansour, M.; Dabbous, M.K.; Kirkpatrick, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

A plan has been developed to test the steam huff-and-puff process (cyclic steam injection) followed by a steam drive in the Ras Gharib tar sand. In this process steam is injected, frequently at overburden pressures, for a period of time before allowing the well to flow back producing oil and water. Production rates depend on the properties of the oil or tar, the formation and well conditions. In a new reservoir, total production on each steam cycle, as well as the optimum length of the steam cycles, cannot be predicted, but must be determined by trial and error. The initial pilot will consist of a triangular pattern containing Wells TS1, TS2, and TS3. The wells are spaced approximately 50 m apart. Cyclic steam injection will be conducted in each well until thermal communication is established, at which point one of the producers will be converted to continuous steam injection. A 50 million Btu/hour skid-mounted steam generator with water softening system will be used in the pilot test. Laboratory steam tests were conducted on core recovered from Wells RG-243 and RG-244 TS1 to estimate the potential recovery of oil by steam. Additionally, routine core analysis and sieve analysis have been conducted. Logs from Wells RG-244 TS1 and RG-246 TS2 were evaluated to determine net thickness, porosity, and water saturation in the tar-saturated section. Laboratory tests indicate the recovered tar has an API gravity of −4.7°. The melting point of the tar is approximately 128° to 160°. The viscosity of the tar is 300 cp at 200°.

21410 (CONF-850710–, pp. 943-951) **Heavy oil recovery methods - A classification system.** Cornelius, C.D. (VEBA OEL Entwicklungs-GmbH, Gelsenkirchen (West Germany)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The author tried to use a consistent nomenclature of crude/bitumen recovery schemes arranged either according to chronological order or by technological implications. It is also proposed to have in mind a simple classification of reservoir energies, i.e., whether they are internal, endogenous, or external. The HCO/bitumen recovery methods are, if not conventional primary in situ or mining processes, thermal enhanced displacement processes. The necessary pressure is maintained by thermally-stimulated liquid and/or gaseous flood media, which are either injected directly or generated indirectly by electrical currents; the latter imply very unconventional recovery processes. Due to the thermal energy applied, thermal expansion becomes an additional expansion drive mechanism. The thermal HOR processes can be assisted by chemical and/or by mining processes. Side effects like viscosity reduction, oil quality improvement, reduction of interfacial tension, etc., are wanted.

21411 (CONF-850710–, pp. 1023-1032) **Evaluation of additives to enhance the in situ steam processes applied to US and Canadian tar sand and heavy oil reservoirs.** Raplee, B.; Cottrell, F.; Raab, J.; Bohn, J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Diverse additives were subjected to a series of three screening phases to assess their suitability with a steam drive process for recovery of tar sand and heavy oil resources. The resources studied were tar sand materials from Utah and Alberta and heavy oil materials from California and Saskatchewan. The first screening phase, a literature review, identified over 120 potential additives to steam processes. In the succeeding screening phases, these additives were subjected to semiquantitative laboratory evaluations using actual resource materials. Chemical and physical evaluations were conducted during the second screening phase to assess additive enhancement of steam process oil recovery mechanisms, additive thermal stability at steam process temperatures, and additive/matrix interactions. Additives demonstrating potential enhancement of steam process oil recovery, adequate thermal stability, and acceptable additive/matrix interactions were subjected to process simulations in unscaled physical models during the third and final screening phase. The hot water region of a steam drive process was simulated with a hot water drive using an elemental core apparatus. Improvements in oil recovery were established by comparing oil recovery from simulations with additives to a baseline run without an additive. A list of additive/resource combinations was compiled, which demonstrated increased oil recovery.

21412 (CONF-850710–, pp. 1073-1082) **Hydrothermal mineral reactivity studies for an in situ combustion process.** Vlahos, C.K. (Petro-Canada Resources, Production Research and Development, Calgary, Alberta (Canada)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The effects of combustion (burning) on the native reservoir minerals are to oxidize sulfur-containing minerals and compounds (pyrite and oil), generating SO_4^{2-} ions, to cause the formation of meta-kaolinite and the decomposition of carbonate minerals such as siderite. The sulfur content of the reservoir oil is approximately 3.0%, which is significant and may result in very acidic conditions, as has been observed. Thus low pH may create unwanted situations in the downstream zone (towards the production wells), such as the precipitation of iron hydroxide and chlorite mineral generation. The effect of these reactions would be to decrease the permeability of the formation towards the production wells, resulting in the eventual loss of oil production. Significant quantities of carbonate minerals are not present in the reservoir. The effect of the carbonates is to neutralize and buffer the aqueous solutions, thereby minimizing the damage that may result from low pH. Also, significant quantities of iron-bearing minerals are not present in the reservoir. pH values in the order of 3 to 4 were typically observed during the experiments, for the aqueous chemistries of the fluids used in the experiments were reasonably well defined. It becomes apparent that if future combustion tube work is to be performed, then detailed monitoring of the aqueous fluids is essential. This will provide useful information confirming the mineralogical trends anticipated from this study. Remedial treatments for the injection water may then be designed in order to minimize the deleterious effects of decreased pH values in the hydrothermal zones.

21413 (CONF-850710–, pp. 1123-1129) **The bi-provincial project primary upgrading technology: Why ebullated bed hydrocracking (H-Oil®) was chosen.** Quinn, P.C. (Husky Oil Operations Ltd., Calgary, Alberta (Canada)); Jeffries, R.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Husky has been studying heavy oil upgrading processes, based on the Lloydminster and Cold Lake area crudes, since 1965. In January 1980, Husky initiated a process screening study for 12 heavy oil upgrading schemes. The objective of the study was to develop a process configuration to be used as a basis for a more detailed engineering study of the feasibility of constructing a heavy crude oil upgrader in the Lloydminster field. The study included a process technology screening assessment and a technical, cost, and operability analysis. In addition, the flexibility of the process to deal with various heavy oil feedstocks, technical and operational constraints, environmental factors, the ability to maximize yield of liquid products, energy efficiency, and the production of a marketable product were assessed. The upgrading technologies studied included delayed coking, fluid coking, Flexicoking, Eureka, H-Oil 60% conversion, H-Oil 95% conversion, LC-Fining, LC-Fining with gas oil recycle, Gulf HDS, CANMET, HRI Dynacracking, and VEBA Combi-Cracking. Preliminary heat and material balances, utility balances, and block process flow sheets were prepared for each case. Initial capital cost estimates were determined utilizing curve-type cost estimating techniques, and preliminary operating costs were calculated.

21414 (CONF-850710–, pp. 1317-1324) **High conversion H-Oil ® processing of Cold Lake and Lloydminster residues in support of Husky bi-provincial project.** Wisdom, L.I. (HRI, Inc., Gibbsboro, NJ (USA)); Colyar, J.J.; Jeffries, R.B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In September 1983, Husky Oil Operations Ltd. made a proposal to the governments of Canada, Alberta, and Saskatchewan to build an upgrader near the city of Lloydminster, Saskatchewan. The Bi-Provincial Project is an integrated heavy oil production and upgrading facility, which will process 54,000 barrels per day of heavy oil from the fields of Lloydminster and Cold Lake. As part of Husky's technical evaluation of various upgrading technologies, a pilot plant program was awarded to HRI in June 1984 to evaluate high conversion H-Oil processing of the Cold Lake and Lloydminster atmospheric residua. This program confirmed that high conversion H-Oil technology can be successfully applied to Cold Lake bitumen at commercial design pressures, temperatures, and catalyst consumption rates. The objectives of the pilot plant program were to confirm operability and develop a data base for high conversion H-Oil processing of Cold Lake atmospheric residua and a blend of Cold Lake and Lloydminster residua. A target vacuum resid conversion level of 85 v% was chosen by Husky for the commercial design, with the unconverted residuum being utilized in a Texaco Synthesis Gas Generation Process unit for hydrogen production.

21415 (EMR–89-06352) **Lloydminister upgrader.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1989]. 7p. (MICROLOG–89-06352). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A general explanation is presented of the crude oil upgrader to be constructed in Saskatchewan near the Alberta border. The upgrader will use western Canada's abundant supplies of heavy oil and bitumen and convert them into synthetic crude to be sent to eastern refineries. Most of the feedstock is expected to come from the Cold Lake and Lloydminster reservoirs. The construction and operation of the upgrader is expected to have significant economic impact on western Canada, and additional benefits to the rest of Canada in the form of spinoffs through secondary industries. Negotiations to build the upgrader began in 1982, and agreement was reached in 1988 between Husky Oil and the governments of Canada, Alberta, and Saskatchewan to proceed with the project, which is scheduled for completion in 1992.

21416 (EMR–89-06353) **Lloydminster bi-provincial upgrader: Background papers.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1989]. 14p. (MICROLOG–89-06353). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In 1988, an agreement was reached between Husky Oil and the governments of Canada, Alberta, and Saskatchewan to build a regional upgrader facility for producing synthetic crude oil from western Canadian heavy oil and bitumen. Elements of the joint venture agreement are summarized, and data are presented on the upgrader-related expenditures and employment, which are expected to be part of the economic impact of the upgrader. A simplified description of the upgrading process is also provided. The upgrader will take 40,000 bbl/d of heavy crudes from the Lloydminster and Cold Lake regions and subject it to fractionation. Residue from the fractionation step will be fed to a proprietary H-Oil Process, the heart of the upgrading complex, which will remove a large part of the sulfur and heavy metals and produce light oil products. Useful byproducts produced by the upgrader include low-sulfur coke, low-sulfur fuel gas, and elemental sulfur. 3 figs.

21417 (EMR/CR–89-06211) **Microscopic characterization of oil sands processing emulsions.** Mikula, R.J. (Energy, Mines and Resources Canada, Devon, AB (Canada)); Munoz, V.A.; Lam, W.W. Department of Energy, Mines and Resources, Ottawa, ON (Canada). Coal Research Labs. Div. Mar 1989. 28p. (MICROLOG–89-06211). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources

Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The microscopic characterization of oil sands emulsions formed in the presence of additives such as sodium hydroxide can be important in the prediction of the processing characteristics and process yields in the extraction of oil from oil sands. The size distribution of the emulsion can determine how efficiently the oil can be separated from the water, and by what means: mechanically or chemically. In addition, it is possible to characterize the nature of the dispersed phase by observing fluorescence behavior under an optical microscope, or via x-ray analysis with a scanning electron microscope. In certain cases, it is also possible to characterize the interface between the dispersed and the continuous phases. This paper presents laboratory results using microscopic techniques, and illustrates their utility, not only for determining the morphology of these economically important emulsions, but also for characterizing the composition of the interface itself. 18 refs., 14 figs.

21418 (MC/SC–AS/87/26) **Intergrated retorting combustion system using fixed bed technology: Final report.** Barua, S.K. (Monenco Consultants Ltd., St. Catherines, ON (Canada)); Robson, R.; Salib, P. Monenco Consultants Ltd., St. Catherines, ON (Canada); Research and Productivity Council, NB (Canada). 3 Dec 1987. 200p. (MICROLOG–90-00180). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The primary objective of this study was to carry out an extended run for 48 hours duration using the Reseach and Productivity Council (RPC)'s Intergrated System, which consists of a circulating fluidized bed combustor and a fixed bed retort. In this system, the pyrolysis (retorting) of oil shale is carried out to produce liquid and gaseous fuels and a by-product spent shale. The heat of retorting is supplied by the flue gases from a circulating fluidized bed combustor operating on a mixture of spent shale and a high suphur coal. The spent shale, which contains calcium and magnesium oxides, acts as a sulphur capture media. Excess heat from the combustor would be used for steam raising and power generation. The circulating fluidized bed combustor system was started up and operated trouble-free for the entire duration of the 57 hours of the intergrated combustion/retorting run. Minor operational problems were encountered with the retort. Optimum operating conditions were sustained for 20 hours of continous operation, during which the oil recovery was 97.4% of the Fischer assay of the oil shale. The quality of the produced oil compared favourably with that obtained in previous work carried out at the RPC. The combustion efficiency was 90%. Sulphur capture was low because of the low Ca/S molar ratio; a much higher spent shale to coal ratio will be needed to further reduce the sulphur emission. The oil obtained is as light as a Kuwaiti crude. The calorific value of the product gas during the steady state was 134 BTU/ft^3. The spent shale retained over 29% of the calorific value of the fresh shale. The heat exhanger should be modified or redesigned to adequately preheat the middle recycling gas. 2 refs., 12 figs., 25 tabs.

21419 (PCCIM–CE02873, pp. 38-38.8, Paper38) **Exploitation of shallow oil sands beyond surface mining limits.** Stephenson, H.G. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

In-situ methods of bitumen recovery using horizontal wells from tunnels below the reservoir are being tested at the Underground Test Facility (UTF) near Ft. McMurray, Alberta. The results to date have been excellent. This paper proposes that the concepts being tested at the UTF. under 140m of overburden are likely to be applicable in very shallow oil sand, just beyond the economic limits of surface mining, at depths of 50m to 100m. Such operations would have the benefits of easy access by inclined tunnels and the capability to utilize the existing infrastructure constructed for surface mines and plants. The concept is explained, and formally compared to surface mining. The potential for a number of such operations, each supplying product to an existing oil sands plant or a central upgrader, is likely to be technically feasible and economically attractive; however, the economic evaluation of the concept remains to be done. 5 refs., 2 figs., 1 tab.

21420 (PCCIM–CE02873, pp. 31-31.14, Paper 31) **Field observations of steam distribution during injection to the Cold Lake Reservoir.** Kry, P.R. (Esso Resources Canada Ltd. (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Initial heating of heavy oil reservoirs by steam injection requires high pressures which disturb the matrix. This disturbance creates regions of enhanced porosity and permeability which can have an effect on the subsequent conformance of heat distribution and bitumen depletion. Pressure observations at injection wells and offset wells during first cycle steam injection have been made at Cold Lake. Injection can occur at pressures less than the minimum in situ stress, and, when this happens, tensile parting cannot be the dominant failure mode. Instead, shear failure of the uncemented sands, coupled with the resulting dilatant behaviour, can account for the observed injection behaviour. Extreme asymmetry and anisotropy characterize the shape of the failed zone. Disturbed zones in the reservoir initiated from horizontal fractures have aspect ratios as extreme as 1:10 and have typically propagated to distances exceeding the well spacing after injection of a fraction of the scheduled steam. They are 2 to 3 times as extensive on the up-dip side of the well as on the down-dip side. By the end of the injection, only a small fraction of the water-equivalent steam column injected has leaked outside the pore volume of the disturbed zone in the reservoir. 17 refs., 7 figs., 4 tabs.

21421 (PCCIM–CE02873, pp. 23-23.12, Paper 23) **Coal, a fuel option for heavy oil recovery operations.** Aiello, J.P. (Esso Resources Canada Ltd. (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Coal is the most abundant energy resource in Canada, and its proximity to the major oil sands resources in Alberta makes it a natural contender as a fuel option for heavy oil recovery. This paper deals with the evaluation methodology and the outlook of Esso on the most promising coal utilization technologies and describes the status of a demonstration project in which Esso is currently involved; a majority of the technical and economic considerations associated with the conversion from natural gas fuel to coal fuel could apply to any oil-field and industrial boilers or steam generators. The history of the development of the Cold Lake deposit is recalled. The current bitumen production is of approximately 14,000m3/d; the coal requirement associated with this level of production is 1.3M tonnes/y. This could exceed 5M tonnes/y, depending on the extent of future evelopment at Cold Lake. The logistic of coal, the utilization technologies available, the problelm of the emission of pollutants, and the transportation problems are outlined. The economic evaluation of coal compared to natural gas is discessed. The most promising utilization technologies are the conventional pulverized soal boiler, the LNS (low NOx/SOx) burner with a conventional oil field steam generator and the combustion of micronized coal in a conventional oil field steam generator; these 3 technologies are compared as to their emission levels, retrofitting capability, production of soli waste, and technical risk. Late in 1988, Esso and Trans Alberta Resorces agreed to proceed with a demonstration facility at Cold Lake utilizing the LNS burner technology with a modified oil-field generator fired at a rate of 53GJ/h, subject to final funding arrangements. 4 refs., 4 figs., 1 tab.

21422 (PCCIM–CE02873, pp. 32.1-32.11, Paper 32) **Large scale laboratory fracturing test in oil sands.** Kosar, K.M.; Been, K. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

The economical development of the oil sands reserves of Alberta depends on the ability of operators to design efficient hydraulic fracturing strategies. The prediction of fracture growth in unconsolidated reservoirs, however, is difficult as conventional mathematical models fail to incorporate important behavioral characteristics of uncemented clastic sediments. In order to better understand the hydraulic fracturing phenomenon in uncemented oil sands, a large-scale laboratory simulation has been carried out. The compaction of the oil sands sample from the Fort MacMurray formation, its consolidation within the experimental container, the injection of cement through a hollow rod, its solidification, and the observed shape of the fracture are described. The sequence of events is described, and the process of fracture development is interpreted. It is considered that the nature of the fracture observed is dominated by the influence of the dilatancy of the sand. Unlike field tests, which are subject to several unknown factors, such laboratory data may be used directly to enhance the mathematical models for fracture analysis. 3 refs., 8 figs.

21423 (PCCIM–CE02873, pp. 34.1-34.9, Paper 34) **Geomechanics monitoring of cyclic steam stimulation operations in the Clearwater Formation.** Gronseth, J.M. (Esso Resources Canada Ltd. (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Cyclic steam stimulation is used to produce bitumen from the Clearwater Formation near Cold Lake, Alberta. In this operation, predetermined volumes of steam are injected into the formation at high pressure and temperature to reduce the viscosity of the bitumen, enabling it to flow to the wellbore at commercial rates. A geomechanics monitoring program was initiated to characterize the role that the mechanical response of the reservoir has on bitumen production and casing impairments. In situ stress determinations by hydraulic fracturing have proven to be a useful tool for characterizing steam driven hydraulic fracture behavior. The process of cyclic stream stimulation was found to alter the magnitude of the minimum horizinotal stress. Stress field alterations were found to be of a sufficient magnitude to cause a change in hydraulic fracture orientation from vertical to horizontal. Near-surface vertical displacement measurements made on arrays of vertical control quality benchmarks and subsurface vertical displacement measurements made using extensometer wells show that extensional displacements are induced in the result of reservoir dilation. The recovery of these strains during production operations in an important source of reservior drive energy. Inclinometer wells were used to determine that shear displacements caused by slippage at the interface between the Clearwater and adjacent Grand Rapids Formation is the most likely cause for production casing deformations that have been experienced at that location. The results from this program have been provided valuable insights into the production mechanisms and the mechanics of casing impairments. 14 refs., 6 figs

21424 (STA/O–167-87-30) **Deasphalting of non-conventional residues and catalytic cracking of de-asphated oils by metal-tolerant catalyst (Part of the Program of the Federal Panel on Energy R & D [PERD]): Task 8 DA and FCC process modelling. Final report.** Sheridan Technical Associates, Inc., Oakville, ON (Canada). Mar 1989. 95p. Contract EMR 23440-7-9126/01SQ. (MICROLOG–89-04487). Available from Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1. Prices: PRICES UPON REQUEST.

Work performed in a related report on deasphalting and catalytic cracking recommended fully utilizing the experimental data via modelling and correlation. The work described in this report address four model applications. The experimental phase behavior reported during the deasphalting of Lloydminster and Athabasca vacuum tower bottoms (VTB) was matched via a model utilizing the Flory-Huggins-Regular Solution equation, in order to permit calculation of phase behavior over a complete range of solvent-VTB ratios. The Weekman-Nace kinetic model was fit to microactivity test data from catalytic cracking of 29 deasphalted (DA) oils and 2 vacuum gas oils (VGO). Rate constants were derived for gas oil cracking, gasoline formation, and gasoline cracking. Using the same rate constants, the performance of a commercial heat-balanced riser fluid catalytic cracking unit using selected DA oils as feedstock, was modelled. The experimental microactivity test data measured for clay extracted derivatives and dimethyl sulfoxide-treated raffinates, coprocessing oils, and shale oils were fitted to the Weekman-Nace model. A summary of the salient features of the model used for each of the four applications is included, with a more detailed description, along with examples of computer program outputs, in the appendices. 8 refs., 17 figs., 17 tabs.

21425 (STA/O–190-89-30) **Deasphalting of non-conventional residues and catalytic cracking of de-asphalted oils by metal-tolerant catalyst: Final report.** Sheridan Technical Associates, Inc., Oakville, ON (Canada). Dec 1988. 127p. Contract EMR 23440-7-9126/01SQ. (MICROLOG–89-04487). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This contract was undertaken to study the deasphalting (DA) characteristics of non-conventional residuums and to assess the quality of the resulting deasphalted oils as catalytic cracking feedstock. The objective was to provide a good experimental data base for assessing the applicability of deasphalting and catalytic cracking technology to non-conventional residuum upgrading. Two typical non-conventional residuums from Athabasca and Lloydminster were selected for the study. These materials were deasphalted using four solvents (propane, n-butane, n-pentane, and n-heptane) over a range of solvent/oil ratios and temperatures. Sufficient deasphalting experimentation with feed and product testing was carried out to develop ternary phase envelopes for the eight sovent/residuum systems and to define the effect of solvent and conditions on DA oil yield and quality. Selected DA oils were also catalytically cracked over a range of severities using a modified microactivity test reactor and commercial equilibrium catalyst. The resulting yields profiles were used to further assess the cracking characteristics of non-conventional DA oils. The overall results from this study showed similar trends to literature data reported for conventional residuums. DA oil yield and quality can be correlated with feedstock quality, solvent selection and operating conditions. Futhermore, DA oil composition can be used to estimate catalytic cracking yields and evaluate the suitability of the material as a feedstock to a fluidized catalytic cracking unit. 17 refs., 77 figs., 29 tabs.

0405 Properties and Composition

Refer also to citation(s) 21149, 22190

21426 (CONF-850710–, pp. 373-379) **Chemical composition of bitumen extracts from Nigerian tar sands.** Oluwole, F.F. (Univ. of Ife (Nigeria)); Adegoke, O.S.; Kehinde, L.O.; Borisade, A.B.; Ako, B.D.; Ajayi, T.R.; Enu, E.I.; Nwachukwu, J.I.; Coker, S.J.L.; Wallace, D. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude*

and tar sands. Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Bitumens extracted from Nigerian tar sands were analyzed for major and trace elements by the ASTM method and Fast Neutron Activation Analysis and further characterized by liquid and gas chromatography. Comparison with mean values for seven conventional Nigerian light crudes and an Athabasca bitumen shows that the Nigerian bitumens have higher C, H, and O contents than the Athabasca bitumen, and lower C and H and higher O than the conventional crudes. The sulfur (1.1 wt%), Ni (35 ppm), and V (32.5 ppm) contents are lower than the Athabasca (5 wt% S, 74.9 ppm Ni, and 198 ppm V), but higher than those of conventional Nigerian crudes (S = 0.65 wt%) and are indicative of biodegradation. The Ca and Fe contents of the Nigerian bitumens are higher while the K, Mg, and Na contents are lower than the Athabasca. The latter may enhance the upgrading and refining qualities of the Nigerian bitumens. The gross hydrocarbon composition of the Nigerian bitumen shows higher resins and asphaltenes and lower aromatics than the Athabasca, suggesting that the Nigerian bitumens may be less suitable for fuel and petrochemical production. Gas chromatographic analysis of one Nigerian bitumen shows the presence of n-alkanes (nC_9-nC_{22}) and various aromatics, most of which show different degrees of degradation, with the aromatics being more resistant.

21427 (CONF-850710–, pp. 381-392) **Problems in the analysis and characterization of bitumen and heavy oils.** Reichert, C. (Alberta Research Council, Edmonton (Canada)); Fuhr, B.J.; Koots, J.A.; Wallace, D. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands*. Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Correct sampling procedures, sample preparation, and the use of suitable methods are vital to good analyses. Data from Round Robin studies on the analysis of bitumen and heavy oil are presented to illustrate some of the difficulties that are encountered. These data point out that systematic error, rather than normal scatter, is usually observed between laboratories. Some of the problems contributing to this bias are presented, together with a discussion of special problem areas. Over the years many procedures have been developed for the characterization of petroleum products. The higher molecular weights of heavy oils and bitumens have added considerably to the difficulties in applying these methods. Recent developments in gas chromatographic distillation, supercritical fluid chromatography, and thin layer chromatography with flame ionization detection have expanded the capabilities to examine the composition of the heavy oils. Examples of these techniques are presented, together with difficulties and shortcomings of many of the present methods of characterization.

21428 (PCCIM–CE02873, pp. 33.1-33.35, Paper 33) **Rheology of water-in-heavy oil emulsions.** Coskuner, G. (Petroleum Recovery Inst., Calgary, AB (Canada)); Maini, B. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges*. Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Most of the worlds's heavy crude oil is produced as emulsions. In situ formation of emulsions is believed to be one cause of poor heavy oil recovery. Emulsions are also detrimental to the pumping efficiency in production wells. The flow of heavy oil emulsions in porous media as well as the rheology of thee emulsions are poorly understood. Therefore, there is a need to develop an improved understanding of the behavior of such emulsions. Most of the reported studies of oil field emulsions have involved the oil-in-water type emulsions, and little information exists for water-in-oil systems. The paper presents a comprehensive review of currently available information on the rheological behavior of water-in-heavy oil emulsions. Factors which affect the properties of such emulsions are examined, and areas where the available information is deficient are identified. The influence of flocculation is discussed. In view of the extremely complex nature of these emulsions, phenomenological models based on studies of macrorheology appear to be the most advantageous method of investigation. Results of rheological measurements on an Athabascan wellhead sample of a heavy oil which contained emulsified water, are presented. These results show mildly shear-thinning behaviour; also the emulsion became less non-Newtonian at elevated temperatures. 87 refs., 9 figs., 1 tab.

21429 (UCRL–99776-Rev.1) **Development of a detailed model of petroleum formation, destruction, and expulsion from lacustrine and marine source rocks.** Burnham, A.K.; Braun, R.L. Lawrence Livermore National Lab., CA (USA). Jan 1990. 32p. Sponsored by U.S. DOE Energy Research; U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-890920–3-Rev.1: 14. international conference on organic geochemistry, Paris (France), 18-22 Sep 1989). Order Number DE90007850. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A variety of laboratory experiments, including programmed micropyrolysis, isothermal fluidized-bed pyrolysis, oil evolution from a self-purging reactor, pyrolysis-mass spectrometry, and hydrous pyrolysis are analyzed to derive chemical kinetic expressions for pyrolysis of lacustrine and marine kerogens. These kinetic parameters are incorporated into an improved, detailed chemical-kinetic model which includes oil and gas generation from kerogen, oil degradation by coking and cracking, gas generation from residual kerogen, and hydrogen consumption reactions. Oil is described by eleven boiling-point fractions of two chemical types. The model includes equation-of-state calculations of vapor/liquid equilibria and PVT behavior. The model can simulate closed, open, and leaky systems, and the open system can include an inert-gas purge. The porosity is calculated for both unconstrained conditions as well as conditions simulating natural compaction and fracturing during sedimentary burial. Model calculations are compared to results from a variety of laboratory experiments, including hydrous pyrolysis. Oil expulsion efficiencies and properties are also calculated for a variety of geological conditions. The relative amounts of water and hydrocarbon phase(s) expelled are governed by saturation-dependent relative permeabilities. Gas/oil ratios in the expelled petroleum are related to organic content and geological heating rate. 52 refs., 10 figs., 4 tabs.

21430 (UCRL–102702) **Nitrogen chemistry during oil shale pyrolysis.** Oh, Myongsook S.; Crawford, R.W.; Foster, K.G.; Alcaraz, A. Lawrence Livermore National Lab., CA (USA). 10 Jan 1990. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-891167–4: Eastern oil shale symposium, Lexington, KY (USA), 15-17 Nov 1989). Order Number DE90007851. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Real time evolution of ammonia (NH_3) and hydrogen cyanide (HCN), two major nitrogen-containing volatiles evolved during oil shale pyrolysis, was measured by means of a mass spectrometer using chemical ionization and by infrared spectroscopy. While the on-line monitoring of NH_3 in oil shale pyrolysis games was possible by both techniques, HCN measurements were only possible by IR. We studied one Green River Formation oil shale and one New Albany oil shale. The ammonia from the Green River oil shale showed one broad NH_3 peak maximizing at a high temperature. For both oil shales, most NH_3 evolves at temperatures above oil-evolving temperature. The important factors governing ammonia salts such as Buddingtonite in Green River oil shales, the distribution of nitrogen functional groups in kerogen, and the retorting conditions. The gas phase reactions, such as NH_3 decomposition and HCN conversion reactions, also play an important role in the distribution of nitrogen volatiles, especially at high temperatures. Although pyrolysis studies of model compounds suggests the primary nitrogen product from kerogen pyrolysis to be HCN at high temperatures, we found only a trace amount of HCN at oil-evolving temperatures and none at high temperatures ($T > 600°C$). 24 refs., 6 figs., 2 tabs.

0408 Economic, Industrial, and Business Aspects

21431 (CONF-850710–, pp. 3-7) **International cooperation concerning heavy crude and tar sands.** Meyer, R.F. (ed.) (Geological Survey, Reston, VA (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

International cooperations in the form of investments, exchange of information, and sharing of experience has long been practiced by the petroleum industry. It is particularly important for heavy crude and tar sands because of the relatively short time in which they have been commercially developed and the sophisticated technology involved. In this paper, a brief overview of the state of the heavy crude and tar sands industry in the world today is presented.

21432 (CONF-850710–, pp. 9-12) **Seven years of successful Venezuelan-German projects in heavy oil production and upgrading.** Herrera, A. (MENEVEN, Puerto La Cruz (Venezuela)); Neef, H.J. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The German-Venezuela agreement for scientific and technical cooperation was signed in 1978. Since then, under the auspices of this agreement, research and development projects have been carried out for the optimum utilization of the heavy and extra-heavy crudes. A feasibility study on the integrated production and upgrading of Orinoco oil was carried out until 1982, and this found that hydrogenation processes had advantages over the coker processes with regard to flexibility, high conversion rates, and low pollution (SO_2, coke). In a second phase, planned to finish at the beginning of 1985, essential aspects of heavy oil production, upgrading, and energy production from residues will be worked out in detail. It has been agreed to continue work until 1987. The success of the Venezuelan-German cooperation depends on a few important boundary conditions: The cooperation benefits all participants; important research and development (R and D) questions on heavy oil production, upgrading, and energy production have been solved jointly and have produced quantifiable results; the costs of the cooperation are being born by Venezuela and Germany jointly on the one hand with contributions from both industry and public funds on the other (DM 100 million 1978-1987); the close cooperation between Venezuelan and German experts has produced a basis of confidence, which has helped to solve all daily problems of the cooperation up to now; the conditions for the cooperation allowed the changing influences of the international energy market to be managed with flexibility. On a governmental and industrial level, the partners in the cooperation are certain that the successful execution of the R and D projects will continue to form a basis for a balanced and expandable commercial connection between the two countries.

21433 (CONF-850710–, pp. 933-940) **U.S. tar sand oil recovery projects - 1985.** Marchant, L.C. (Western Research Institute, Laramie (USA)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Since crude oil prices declined in the early 1980s, U.S. tar sand activities have declined to a level approximating that of the early 1970s. Twenty of the 43 reported projects are in California reservoirs containing bitumen with relatively low viscosities. Only four current or planned projects are reported in states other than California. The data reported for each project include the operator name, project location, project status (completed, current or planned), project type (commercial or pilot), recovery technological and oil characteristics.

21434 (PCCIM–CE02873, pp. 46.1-46.15, Paper 46) **Transforming a white collar professional organization.** Zee, C. (Esso Resources Canada Ltd., Calgary, AB (Canada)); Wershler, D. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

A redesign project in 1988/89 transformed the Cold Lake Engineering and Projects Groups from a functional, hierarchical organization with multiple Interface inefficiences to a whole-task, team-based organization tailored to the pursuit of business opportunities, with parallel emphasis on technical excellence. Various organizational excellence and development theories and practices were investigated in the process of developing a customized design and implementation approach. The high involvement, joint-development approach and the focus on the implementation process were keys to the significant success of the project. Learnings from this project are now being shared with affiliates in the ESSO group of companies on a joint-learning basis.

0409 Waste Management

Refer also to citation(s) 21302, 21392, 21439

21435 (CONF-850710–, pp. 761-770) **Tailings pond bitumen extraction and sludge solidification.** Prasad, B.D. (Energy Resources Conservation Board, Calgary, Alberta (Canada)); Joshi, R.C. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Tailings resulting from the hot-water extraction process during bitumen recovery are sorted within man-made dykes or ponds. The tailings consist of sand, fines, water, and bitumen not being recovered by the extraction process. Most of the sand captured from the tailings is used to construct the dykes. A small percentage of sand and clay settles to the bottom of the pond. After a few years of operation the upper layer of tailings, mainly clear water, is reclaimed to be reused in the extraction process, while the layer below this, i.e., the sludge layer containing bitumen and fines, remains suspended in water. In the study discussed in this paper, lime was added to tailings sludge produced from an oil sands mining project to determine to what extent it would facilitate bitumen recovery, while solidyfing the sludge and strengthening the recovered solids over time. Centrifugation of the lime-sludge slurry was necessary to stimulate recovery of bitumen and separation of water. The results indicated that 64% of the bitumen and 73% of the water could possibly be recovered from the sludge with very small amounts of lime additives. The treatment of the sludge could reduce the volume of the sludge and water in the pond by about 36% of the total tailings, which would minimize sterilization of resources underlying the tailings pond by permitting future use of this site for discard storage

purposes. This, in turn, would have a major beneficial effect on the environment, since the toxic sludge is a potential hazard should there be any failure of the tailings impoundment.

0410 Environmental Aspects

Refer also to citation(s) 21914

21436 (CONF-850710–, pp. 1569-1573) **Selection and application of an atmospheric dispersion model for tropical environments.** Octavio, K.H. (INTEVEP, S.A., Caracas (Venezuela)); Wenzel, F.; Eitschberger, B. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Environmental protection is an integral part of the plans for the exploration, production, and upgrading of the heavy oil reserves in the Venezuelan Heavy Oil Belt. One important task in the assessment of the environmental impact of future projects is the calculation of concentrations of atmospheric pollutants due to present and planned emission sources. Since atmospheric dispersion models have typically been developed for the temperate zones, existing models were reviewed to select models that could be modified and/or applied to tropical environments. The criteria utilized to select a model to be used in Venezuela are presented, as well as the results of an application of the selected model for a proposed 100,000 BPD upgrading complex. The dispersion parameters were found to be the principal difference between temperate and tropical applications. Recommendations for refining the dispersion parameter relations for tropical regions, including measurement methods and devices, are given.

21437 (CONF-850710–, pp. 1575-1583) **Environmental aspects of heavy crude and tar sands exploration, production, and transportation with special reference to Nigeria.** Nwankwo, J.N. (Nigerian National Petroleum Corp., Lagos (Nigeria)). United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Tar sand deposits have been relatively unimportant as an energy source. But increasing demands for energy worldwide have prompted a greater effort to exploit the energy stored in bituminous tar sand deposits. In Nigeria, government policy has shifted toward greater diversification of the country energy resource base and internal self-sufficiency. With the establishment of a lube oil plant at Kaduna Refinery, which now processes heavy crude oil imported from Venezuela, a consensus has emerged on a national energy policy that encourages the exploration and production of the nations heavy crude oil and tar sand oil reserves. The proven reserves of heavy oil of Nigeria occur in the same ecologically sensitive mangrove environments of the Niger Delta where current oil exploration and exploitation is going on. However, the tar sand deposits are concentrated along the upper fringe of the delta in an equally sensitive agricultural environment. Their operational experience with the handling of heavy oils has been so far limited to transportation and storage; based on this, an average of abut 500 barrels of this grade of oil was being lost to the offshore environment of Nigeria during each shipment of an average parcel of 1 million barrels. The ecological impacts of these spills and the other possible problems that could arise from the exploration and exploitation of the heavy crude oil deposits and tar sands in Nigeria have been examined in this paper. It is concluded that any large-scale efforts directed towards the exploitation and utilization of their heavy crude oil and tar sand reserves will definitely aggravate the environmental assault occasioned by current oil field activities in Nigeria.

21438 (CONF-850710–, pp. 1585-1590) **Saskatchewan heavy oil deposit environmental constraints study.** Lewis, L. (Petro-Canada Environmental and Social Affairs, Calgary, Alberta (Canada)); Robertson, M.R. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The study, prepared for Gulf Canada Resources, Petro-Canada Inc., and Saskatchewan Oil and Gas Corporation, identified the biophysical features and potential environmental problems within 20,000 ha of jointly held land forming the Saskatchewan Heavy Oil Project. The approach divided the study area into biophysically similar units of land. For each unit, ratings from low to high were given on the likelihood that expansive soils, flooding, slope failure, and erosion would be encountered. Ratings were also given for archaeological potential, probable water and aggregate supplies, and suitability for light foundation construction, waste disposal, surface reclamation, and wildlife. By using the reports text and figures, heavy oil staff of the partner companies were able to review constraints and features of the SHOP lands, which may affect their work. Government requests for information were also rapidly and effectively addressed, the findings incorporated in regional planning decisions, and public acceptance of SHOP long-term development goals heightened.

21439 (PCCIM–CE02873, pp. 1-13, Paper 42) **Syncrude Canada Ltd. Environmental challenges into the 1990's.** Rettalack, J.T. (Syncrude Canada Ltd., Fort McMurray, AB (Canada)); Anderson, E.; Friesen, B.C. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Syncrude Canada Limited operates an oil sands plant at Mildred Lake, about 400km north of Edmonton. The Syncrude project is based on open-pit mining and, over the current project life, will produce more than 1Gbbl of oil. In the original planning of the Syncrude project, a commitment was made to sound environmental management. The objectives of this paper are to review the approach that Syncrude has taken in the management of various environmental challenges, both past and present, and to suggest directions that are appropriate to maintain a positive approach to future challenges. The management of liquid and sludge-solids waste material is discussed. The surface drainage pattern was altered to divert all natural water flow away from the plant site, and a tailings pond was constructed. Evidence to date supports the feasibility of the sludge capping option. The planning and execution of short- and long-range reclamation are discussed. Some 1200 hectares of land and water have already been permanently reclaimed, and are currently being monitored to determine reclamation adequacy. The environmental regulatory context is presented. Public participation in environmental approval processes has been fully implemented. The experience acquired by Syncrude in facing environmental challenges can be of use for other similar projects. 5 refs.

0420 Legislation and Regulations

21440 (CONF-850710–, pp. 13-18) **The establishment of a legal framework for the development of heavy crude and tar sands resources.** Pechota, V. (Columbia Univ., New York, NY (USA)). United Nations Development Programme, New York, NY

(USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

This paper is concerned with the legal aspects of exploration for and exploitation of heavy crude and tar sands deposits in various countries. The principal issues to be addressed include: transnational approaches; national legislation and regulations; and the need for harmonization, unification, and development of the law on the subject.

0430 Transport, Handling, and Storage

Refer also to citation(s) 21333, 21334, 21335, 21341, 21342, 21343, 21344, 21345, 21346, 21347, 21348

0440 Combustion

Refer also to citation(s) 21349

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 21161

0504 Feed Processing

21441 (DP–1776) **Reactions during the processing of U_3O_8-Al cermet fuels.** Marra, J.E.; Peacock, H.B. Westinghouse Savannah River Co., Aiken, SC (USA). Jan 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90008127. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The cermet fuel (U_3O_8 dispersed in Al) being considered for use in the Savannah River Site reactors is thermodynamically unstable due to the potential for a metallothermic reduction reaction. The exothermic reaction between U_3O_8 and Al produces approximately 225 calories of heat for every gram of oxide consumed. During processing of the U_3O_8-Al cermet fuels by Powder Metallurgy (P/M) techniques, a significant portion of the U_3O_8 is reduced to U_4O_9. The reaction between U_4O_9 and Al is also exothermic, however, the maximum heat released by the reaction is approximately 80 calories per gram of oxide reacted. Metallothermic reduction reactions for U_3O_8/U_4O_9/Al mixtures do not occur at the normal reactor operating temperature (~100°C) or at temperatures below the melting point of aluminum (660°C). This report describes work performed to quantify the extent of reaction during P/M processing of the U_3O_8-Al cermet fuel, and to determine the effect of reduction to U_4O_9 on the metallothermic reduction reaction.

21442 (JAERI-M–89-163) **Differential thermal analyzer for research on plutonium fuels and its application to analysis of phase diagrams for alloy systems.** Suzuki, Yasufumi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sasayama, Tatsuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 24p. (In Japanese). Order Number DE90759900. Available from NTIS (US Sales Only), PC A03/MF A01.

The differential thermal analyzer (DTA) has been installed as a means of the research in phase relationships of actinide alloys and metallic fuels including plutonium. The good ability of the apparatus was confirmed from the examinations of standard materials and uranium metal. The phase relationships of the U-Ni and U-Nd binary alloys prepared by a powder metallurgical method were determined by the DTA. The results on the U-Ni system revealed that the accurate analysis of phase diagrams is available by the DTA. In the U-Nd system, it is suggested that a little Nd may be soluble in the α-U phase, but that the solubility of Nd in the β-U phase may be limited. (author).

21443 (JAERI-M–89-180) **On fabrication of UO_2 microspheres by internal gelation process.** Cao, Xinsheng (Southwest Center for Reactor Engineering Research and Design (China)); Minato, Kazuo; Kobayashi, Fumiaki; Fukuda, Kousaku. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 17p. Order Number DE90759897. Available from NTIS (US Sales Only), PC A03/MF A01.

Microspherical UO_2 kernels for HTGR coated fuel particles were fabricated by the internal gelation process in order to examine some properties of these spheres. Fabrication run was made twice, using different nozzle sizes where droplets of uranium nitrate acid containing hexamethylentetramine and urea were dropped into the warmed paraffin oil. Characterization was made on diameter, sphericity, density, grain size and crushing strength of the sphere, and comparison of surface appearance and fracture surface of the particles fabricated by this process with those by the external process (SNAM process) was made by SEM observation. (author).

21444 (WSRC-RP–89-1100) **Transaction processing in a quality control laboratory.** Aull, J.E. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900580–1: 1990 Digital Equipment Corporation User's Society meeting, New Orleans, LA (USA), 7-11 May 1990). Order Number DE90004655. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sample receiving data is received from VAX 8700 process computer via Ethernet and saved in RDB database on VAX 11/750 lab computer for transmission of results. Data entry pretests include technician qualification and instrument verification by analysis of blind standards. Raw data are transmitted by instruments that talk to ADACS 1200 systems via microprocessors to lab computer which confirms storage to instrument operator. Results are transmitted to process computer by batch job submitted by approving supervisor. Results are archived as samples are disposed. Daily reports of sample load and results are printed. Weekly reports of technician qualification are printed. Scientist and managers retrieve results, sample status, and technician qualification reports via heirarchical menu system. 13 figs.

0505 Uranium Enrichment

21445 (POEF-T–3508) **Performance characteristics of the Fairchild 8A and 8B centrifugal compressors.** Foster, R.E. Martin Marietta Energy Systems, Inc., Piketon, OH (USA). 29 Sep 1989. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-76OR00001. Order Number DE90007847. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Fairchild 8A and 8B centrifugal compressors used in the X-326 isotopic cascade at the Portsmouth Gaseous Diffusion Plant have been modeled using the computer software code COMPAL. Performance characteristics curves for both machines are included for various mixtures of UF_6 and N_2 gases. 8 figs.

21446 **In the beginning: Measurements of uranium.** . White, J.C. (Oak Ridge National Lab., TN (USA)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 18-20 (Nov 1989).

After World War II, Oak Ridge continued to be involved in measurements of uranium materials, both for the weapons program and for early reactor development programs. These early tasks, and some of the people involved in them, are discussed.

21447 **Measurements of minor and trace elements in nuclear materials.** Warf, J.C. (University of Southern California, Los Angeles, CA (USA). Dept. of Chemistry). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 29-31 (Nov 1989).

The author discusses the production of high-purity uranium metal fuel for a reactor. This paper reports how existing methods had to be modified and new methods developed to attain the measurement sensitivity necessary to characterize the uranium product.

0507 Fuels Production and Properties

Refer also to citation(s) 21717, 21731, 21746, 21747, 21748, 21749, 21750, 21751, 21752, 21753, 21754, 21755, 21756, 21757, 21758, 21759, 21760, 21761, 21762, 21763, 21764, 21765, 21766, 21767, 21768, 21769, 21770, 21772, 21773, 21774, 21782, 21783, 21784, 22095, 22936

21448 (DOE/EH/79081–T1) **An assessment of criticality safety at the Department of Energy Rocky Flats Plant, Golden, Colorado, July–September 1989.** SCIENTECH, Inc., Boise, ID (USA). Sep 1989. 220p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC01-88EH79081. (SCIE-DOE–201-89). Order Number DE90007566. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This is a report on the 1989 independent Criticality Safety Assessment of the Rocky Flats Plant, primarily in response to public concerns that nuclear criticality accidents involving plutonium may have occurred at this nuclear weapon component fabrication and processing plant. The report evaluates environmental issues, fissile material storage practices, ventilation system problem areas, and criticality safety practices. While no evidence of a criticality accident was found, several recommendations are made for criticality safety improvements. 9 tabs.

21449 (DP–1770) **A differential thermal analysis study of the effect of tramp impurities on the exothermic U_3O_8-Al reactions.** Gray, L.W. (Lawrence Livermore National Lab., CA (USA)); Peacock, H.B. Savannah River Lab., Aiken, SC (USA). Dec 1989. 52p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. Order Number DE90008124. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Differential thermal analysis (DTA) has been used to study the effect of impurities on aluminothermic reactions between commercial type 101 aluminum powder and U_3O_8 powder. No measurable effect (solid state reactions) was found below 660°C during differential thermal analysis studies of (1) loose blended powders, (2) blended and compressed powders, (3) blended, heated, and compressed powders, or (4) blended, compressed, and heated compacts containing less than 50,000 ppM impurities from group IA halide salts and group IIA oxides. It was determined that impurities (>5 wt %) of alkali metal chlorides, and alkaline earth oxides, cause minor modifications of the reaction thermograms above 800°C for molten aluminum metal with U_3O_8. It was also determined that attempts to prepare alkali, alkaline earth, and transition metal uranates under conditions via reaction below 660°C. In similar experiments where Fe_2O_3 and NiO were substituted for U_3O_8, it was determined that NaCl does modify the reactions between aluminum metal and Fe_2O_3 and between aluminum metal and NiO. With increasing NaCl concentrations, the temperature for initiation of the reaction moves to lower temperatures. At 10 wt % NaCl, the exothermic "thermite" reactions between aluminum and Fe_2O_3 or NiO begin at approximately 640°C. 30 refs., 17 figs., 7 tabs.

21450 (K/ITP–270) **Liquid-phase compositions from vapor-phase analyses: 7, Preliminary calculations concerning arsenic trifluoride (AsFsub 3) and arsenic pentafluoride (AsFsub 5).** Davis, W. Jr. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Cochran, H.D. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). Feb 1990. 49p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90008463. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Arsenic normally is not considered to be a contaminant. However, because arsenic was found in many cylinders of UF_6, including in corrosion products, a study was performed of the distribution of the two arsenic fluorides, AsF_3 and AsF_5, between liquid and vapor phases. The results of the study pertain to condensation or vaporization of liquid UF_6. This study includes use of various experimental data plus many extrapolations necessitated by the meagerness of the experimental data. The results of this study provide additional support for the vapor-liquid equilibrium model of J.M. Prausnitz and his coworkers as a means of describing the distribution of various impurities between vapor and liquid phases of UF_6. Thus, it is concluded that AsF_3 will tend to concentrate in the liquid phase but that the concentration of AsF_5 in the vapor phase will exceed its liquid-phase concentration by a factor of about 7.5, which is in agreement with experimental data. Because the weight of the liquid phase in a condensation operation may be in the range of thousands of times that of the vapor phase, most of any AsF_5 will be in the liquid phase in spite of this separation factor of 7.5. It may also be concluded that any arsenic fluorides fed into a uranium isotope separation plant will either travel with other low-molecular-weight gases or react with materials present in the plant. 25 refs., 3 figs., 6 tabs.

21451 (WSRC-RP–89-981) **Properties of U_3O_8-aluminum cermet fuel.** Peacock, H.B. Westinghouse Savannah River Co., Aiken, SC (USA). Oct 1989. 68p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90008128. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Nuclear fuel elements containing U_3O_8 dispersed in an aluminum matrix have been used in research and test reactors for about 30 years. These elements, sometimes called cermet fuel, are made by powder metallurgical methods (PM) and can accommodate up to approximately 50 wt % uranium in the core section of extruded tubes. Cermet fuel elements have been fabricated and irradiated at the Savannah River Site (SRS). Irradiation behavior is excellent. Extruded tubes with up to 50 wt % uranium have been successfully irradiated to fission densities of about 2×10^{21} fissions per cc of core. Physical, mechanical, and chemical properties of cermet fuels are assembled into a reference document. Results will be used by Argonne National Laboratory to design cermet fuel elements for possible use in the New Production Reactor at SRS. 57 refs., 33 figs., 12 tabs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 22206

21452 (JAERI-M–89-152) **Tritium distribution ratios between the 30 % tributyl phosphate(TBP)-normal dodecane(nDD) organic phase and uranyl nitrate-nitric acid aqueous phase.** Fujine, Sachio (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Uchiyama, Gunzou; Sugikawa, Susumu; Maeda, Mitsuru; Tsujino, Takeshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 17p. Order Number DE90759883. Available from NTIS (US Sales Only), PC A03/MF A01.

Tritium distribution ratios between the organic and aqueous phases were measured for the system of 30 % tributyl phosphate(TBP)-normal dodecane(nDD)/uranyl nitrate-nitric acid water. It was confirmed that tritium is extracted by TBP into the organic phase in both chemical forms of tritiated water (HTO) and tritiated nitric acid (TNO_3). The value of tritium distribution ratio ranged from 0.002 to 0.005 for the conditions of 0-6 mol/L nitric acid, 0.5-800 mCi/L tritium in aqueous phase, and 0-125 g-U/L uranium in organic phase. Isotopic distribution coefficient of tritium between the organic and aqueous phases was observed to be about 0.95. (author).

21453 (JAERI-M–89-168) **Development of partitioning method: Precipitation behavior of other elements in separating the transuranic elements group with oxalic acid.** Kobayashi, Tsutomu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Shirahashi, Koichi; Kubota, Masumitsu. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 29p. (In Japanese). Order Number DE90759906. Available from NTIS (US Sales Only), PC A03/MF A01.

Precipitation behavior of elements in a high-level liquid waste (HLW) was studied by using the simulated liquid waste, when the transuranic elements group was precipitated and separated as oxalate from HLW generated from the reprocessing of spent nuclear fuel. The results showed that over 90 % of strontium and barium were precipitated when oxalic acid was directly added to HLW to precipitate the transuranic elements group, and the percentages of these elements precipitated were affected by molybdenum and or zirconium. Therefore, a method of adding oxalic acid into the filtrate was studied after removing previously molybdenum and zirconium

as precipitate by denitrating HLW, and it was found that precipitated fractions of strontium and barium could be suppressed about 10 %. Adding oxalic acid under the co-existance of ascorbic acid is effective for quantitative precipitation of neptunium in HLW. In this case, it was found that adding ascorbic acid had little influence on precipitation behavior of the other elements except palladium. (author).

21454 (JAERI-M–89-172) **Studies on tritiated water recycle process.** Fujine, Sachio (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Uchiyama, Gunzou; Sugikawa, Susumu; Maeda, Mitsuru; Tsujino, Takeshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 83p. (In Japanese). Order Number DE90759924. Available from NTIS (US Sales Only), PC A05/MF A01.

Tritiated water recycle process is applied for tritium retardation in fuel reprocessing process. Insertion of tritium scrubbing step after the FP scrubbing is a key modification of standard type Purex Process. Main subject of the present report is to study the influence of operation conditions on tritium scrubbing efficiency. Tritium distribution ratios and the amount of tritium chemically exchanged into organic compound were measured using the 30%TBP/nDD and uranyl nitric acid system. Scrubbing was conducted by mini-mixer settler using irradiated and non-irradiated organic solvent. Aqueous phase of the settler in each stage is recycled to the mixer of the same stage in order to reduce the amount of water injected into the process. Evaluation of tritium ballance was conducted for a proposed tritiated water recycle process. Separate experimental studies were conducted by 4 times in series. Result of each experimental study is reported in each chapter in the order. (author).

21455 (NUKEM-FuE–88040) **SBR jacket cutters. Final report.** Alisch, G.; Lang, R. Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1989. 32p. (In German). Contract BMFT KWA 1608 5. Order Number DE90759105. Available from NTIS (US Sales Only), PC A03/MF A01.

Two methods were studied and tested for the separation of fuels and fuel cans from FBR fuel elements: In the rod-slotting method, the fuel rod is helically slit or indented along the longitudinal axis. After tearing up and enlarging the cut, the fuel trickles into a receiving container; the fuel-can may be removed laterally and processed separately. For separation by means of fuel discharge from the fuel cans, the fuel rod is split into short pieces. These pieces are held in a matrix, while a hydraulically operated piston ejects the fuel. In the rod slotting chamber none of the three cutters used could satisfactorily fulfil the requirements on a cutting process for operation in a 'hot cell'. Sections of the fuel rod simulates as long as up to 100 mm could be reliably emptied with the ejection device. The preparatory cutting stage is of enormous importance for the ejection process, since the formation of flashes on the cutting surface towards the pipe centre affects the ejection considerably. (orig./HP).

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Refer also to citation(s) 21466, 21472, 21488, 21505, 21530, 22263

21456 (CONF-900406–40) **The transportation operations system: A description.** Best, R.E. (Science Applications International Corp., Oak Ridge, TN (USA)); Danese, F.L.; Dixon, L.D.; Peterson, R.W.; Pope, R.B. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008405. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper presents a description of the system for transporting radioactive waste that may be deployed to accomplish the assigned system mission, which includes accepting spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from waste generator sites and transporting them to the FWMS destination facilities. The system description presented here contains, in part, irradiated fuel and waste casks, ancillary equipments, truck, rail, and barge transporters, cask and vehicle traffic management organizations, maintenance facilities, and other operations elements. The description is for a fully implemented system, which is not expected to be achieved, however, until several years after initial operations. 6 figs.

21457 (CONF-900587–1) **Personal computer based decision support system for routing nuclear spent fuel.** Chin, Shih-Miao (Oak Ridge National Lab., TN (USA)); Joy, D.S.; Johnson, P.E.; Bobic, S.M.; Miaou, Shaw-Pin. Oak Ridge National Lab., TN (USA). 14 Nov 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 10. TIMS international DSS conference on information technology for executives and managers; Boston, MA (USA); 21-23 May 1990. Order Number DE90005277. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An approach has been formulated to route nuclear spent fuel over the US Interstate highway network. This approach involves the generation of alternative routes so that any potential adverse impacts will not only concentrate on regions along the shortest path between the nuclear power plant and repository. Extensive literature research on the shortest path finding algorithms has been carried out. Consequently, an extremely efficient shortest path algorithm has been implemented and significantly increases the overall system performance. State-of-the-art interactive computer graphics is used. In addition to easy-to-use pop-up menus, full color mapping and display capabilities are also incorporated. All of these features have been implemented on commonly available personal computers. 6 figs., 2 tabs.

21458 (NUREG/CR–4554-Vol.6) **SCANS (Shipping Cask ANalysis System): A microcomputer based analysis system for shipping cask design review: Volume 6, Theory manual: Buckling of circular cylindrical shells.** Lo, T. (Lawrence Livermore National Lab., CA (USA)); Mok, G.C.; Chinn, D.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Lawrence Livermore National Lab., CA (USA). Feb 1990. 74p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-7405-ENG-48. (UCID–20674-Vol.6). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

Under current regulatory requirements, a shipping cask should be designed for a series of hypothetical accident conditions. These test conditions include a 40-inch free drop of the cask onto a 6-inch diameter puncture pin. In this study, existing puncture test data were examined. Simple formulas based on test data were proposed for puncture evaluation of shipping casks. Dynamic and static nonlinear finite element analyses were performed to correlate analyses with the existing test data. In this analytical approach, three puncture failure prediction methods were proposed and their applicability was evaluated. The analytical approach provides an alternative to testing. Both laminated and solid wall shipping casks were analysed. In the study of laminated casks, the effects of the inner shell on the puncture of the outer shell were examined, as were the effects of material strength of the puncture pin. The study of geometric scaling of casks indicated that the normalized incipient puncture energy is insensitive to variations in the scale factors. This conclusion indicates that the proposed analytical approach of combining finite element analysis and failure prediction methods is consistent with the similarity principles in tests, except when local vibration is excited during the puncture process. Further study of this local vibration is needed. 15 refs., 17 figs., 6 tabs.

0520 Waste Management

Refer also to citation(s) 21456, 21539, 21543, 21544, 21545, 21546, 21547, 21841, 22189, 22190, 22204, 22450, 22545, 22546, 22548, 22579

21459 (BNSS–40) **Risks attached to container- and bunker-storage of nuclear waste: The two dry storage options of the Dutch Central Organization for Radioactive Waste (COVRA) discussed further.** Jager, D. de. Rijksuniversiteit Utrecht (Netherlands). Natuurkundewinkel. Dec 1987. 72p. (In Dutch). Order Number DE90706031. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results are presented of a literature study into the risks attached to the dry-storage options selected by the Dutch Central Organization For Radioactive Waste (COVRA): the container- and the bunker-storage for irradiated nuclear-fuel elements and nuclear waste. Since the COVRA does not make it clear how these concepts should have to be realized, the experience aboard with dry interim-storage are considered. In particular the Castor-container-storage and the bunker storage proposed in the committee MINSK (Possibilities of Interim-storage in the Netherlands of Irradiated nuclear-fuel elements and Nuclear waste) are studied further in depth. The committee MINSK has performed a study into the technical realizability of various interim-storage facilities, among which a storage in bunkers. 75 refs., 14 figs., 16 tabs.

21460 (CONF-891119–105) **The reaction of synthetic nuclear waste glass in steam and hydrothermal solution.** Ebert, W.L.; Bates, J.K. Argonne National Lab., IL (USA). [1989]. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90007788. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Glass monoliths of the WVCM 44, WVCM 50, SRL 165, and SRL 202 compositions were reacted in steam and in hydrothermal liquid at 200°C. The glass reaction resulted in the formation of leached surface layers in both environments. The reaction in steam proceeds at a very low rate until precipitates form, after which the glass reaction proceeds at a greater rate. Precipitates were formed on all glass types reacted in steam. The assemblage of phases formed was unique to each glass type, but several precipitates were common to all glasses, including analcime, gyrolite, and weeksite. Reaction in steam occurs in a thin layer of condensed water which becomes saturated with respect to the observed phases after only a few days of reaction. The reaction in steam is accelerated relative to reaction in hydrothermal liquid in the sense that secondary phases from after a shorter reaction time, that is, after less glass has reacted, because of the smaller effective leachant volume present in the steam environment. A knowledge of the secondary phases which form and their influence on the glass reaction rate is crucial to the modeling effort of the repository program. 9 refs., 3 figs., 2 tabs.

21461 (CONF-891119–106) **Comparison of the layer structure of vapor phase and leached SRL glass by use of AEM [analytical electron microscopy].** Biwer, B.M. (Argonne National Lab., IL (USA)); Bates, J.K.; Abrajano, T.A. Jr.; Bradley, J.P. Argonne National Lab., IL (USA). [1989]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90007789. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Test samples of 131 type glass that have been reacted for extended time periods in water vapor atmospheres of different relative humidities and in static leaching solution have been examined to characterize the reaction products. Analytical electron microscopy (AEM) was used to characterize the leached samples, and a complicated layer structure was revealed, consisting of phases that precipitate from solution and also form within the residual glass layer. The precipitated phases include birnes-site, saponite, and an iron species, while the intralayer phases include the U-Ti containing phase brannerite distributed within a matrix consisting of bands of an Fe rich montmorillonite clay. Comparison is made between samples leached at 40°C for 4 years with those leached at 90°C for 3-1/2 years. The samples reacted in water vapor were examined with scanning electron microscopy and show increasing reaction as both the relative humidity and time of reaction increases. These samples also contain a layered structure with reaction products on the glass surface. 15 refs., 5 figs.

21462 (CONF-891129–2) **The use of additives for reducing hydrogen yield in mortar containing slag and chloride salts.** Lewis, M.A.; Warren, D.W. Argonne National Lab., IL (USA). [1989]. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Scientific basis for nuclear waste management; Boston, MA (USA); 27-30 Nov 1989. Order Number DE90007800. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Cementitious waste forms are being considered for immobilizing nuclear waste before disposal. In earlier work, it was found that irradiation of a mortar formulation consisting of slag, portland cement, fly ash, water, and up to 10 wt% KCl–LiCl salt resulted in the generation of hydrogen. Yields were relatively high and the rates of generation were constant for the irradiation period investigated. The addition of small amounts of oxygen-rich electron scavengers to the mortar was investigated as a means for reducing hydrogen yields. The addition of $NaNO_3$ reduced the hydrogen yield; changed the radiolytic products from hydrogen to a mixture of hydrogen, nitrogen, and N_2O; and reduced the pressurization rate after exposure to 400 Mrads. The addition of $NaIO_4$ and $KMnO_4$ reduced hydrogen yields slightly while the addition of Ag_2O increased the yield. Moreover, the addition of FeS to a non-slag mortar changed the radiolysis mechanism but the addition of FeO did not. The results of these experiments provided an insight into the nature of the radiolytic reactions occurring in the mortar formulations and indicated that the radiolytic generation of gases might be controlled with the proper choice of additive. 14 refs., 3 figs., 2 tabs.

21463 (CONF-900406–37) **Hedonic price theory: Concept and applications.** Metz, W.C. (Argonne National Lab., IL (USA)); Lowry, J.; Morey, M. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90007791. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Direct and indirect techniques are being used to estimate economic consequences of proximity to existing or proposed public facilities. The hedonic price theory, an indirect technique, is the most logically suited, especially for capturing the shadow or implicit price of a characteristic such as proximity in the real estate market. While the theory is increasingly being used, there is also a growing tendency to draw inferences from the study of one or more hazards and situations and transfer the conclusions to a very different hazard and situation. The use of the hedonic price theory and the issue of transferability to radioactive waste facilities are addressed in this paper. 12 refs.

21464 (DOE/EH–0096) **Technical safety appraisal of the Lawrence Berkeley Laboratory, University of California.** US-DOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). Feb 1990. 179p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008125. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This report presents the results of one in a series of Technical Safety Appraisals (TSA) of Department of Energy (DOE) operations (nuclear and nonnuclear) being conducted by the Assistant Secretary of Environment, Safety, and Health, Office of Safety Appraisals. TSAs are one of the initiatives announced by the Secretary of Energy on September 18, 1985, to enhance the DOE environment, safety, and health program. This report provides the results of a TSA of the University of California - Lawrence Berkeley Laboratory (UC-LBL) site. LBL is a multiprogram national laboratory managed by UC for DOE. Its role fulfills a four-part mission to perform innovative multi-disciplinary research in the national interest in energy sciences and technology, high-energy and nuclear physics, and environment and health, to develop and operate unique national experimental facilities for use by qualified investigators, to educate and train future generations of scientists and engineers, and to foster the transfer of technology to US industry.

21465 (DOE/HWP–89) **Minutes from Department of Energy Hazardous Waste Remedial Actions Program Technology Demonstration Program FY 1990 waste site review and ranking meeting.** Oak Ridge National Lab., TN (USA). Hazwrap Support Contractor Office. Aug 1989. 140p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. (ORNL/M–917;CONF-8906289–Summ.: Department of Energy Hazardous Waste Remedial Actions Program (HAZWRAP) Technology Demonstration Program waste site review and ranking meeting, Oak Ridge, TN (USA), 21-23 Jun 1989). Order Number DE90006750. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

On June 21-23, 1989, representatives of the Department of Energy (DOE) Headquarters, DOE Operations Offices, several of the prime DOE contractors, and the Hazardous Waste Remedial Actions Program (HAZWRAP) met in Oak Ridge, Tennessee, to review and rank candidate hazardous waste sites for inclusion in the FY 1990 HAZWRAP Technology Demonstration Program. This document summarizes the results of the meeting and includes the ranked list of waste sites. Also included are information sheets on ongoing waste Research and Development projects, ongoing technology demonstration projects, and the 40 candidate projects.

21466 (DOE/ID/12371–T1) **[Rocky Mountain regional low-level waste compact development and establishment of disposals]: Final report.** Colorado Office of the Governor, Denver, CO (USA). 24 Jul 1986. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG07-82ID12371. Order Number DE90007263. Available from NTIS, PC A02/MF A01; OSTI; INIS.

This Compact Issue Study was intended to determine if state institutions in the Rocky Mountain region could reduce low-level radioactive waste shipping and disposal costs through jointly shipping their low-level radioactive wastes. Public institutions in the state of Colorado were used as a test case for this study.

21467 (DOE/LLW–13Tg-Rev.2-Vol.1) **Low level waste management handbook series: Environmental monitoring for low level waste disposal sites: Revision 2: Volume 1.** EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 262p. Sponsored by U.S. DOE Defense Programs; U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90008008. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This document reviews the purpose, objectives, principles, and design of environmental monitoring programs for low-level radioactive waste disposal sites. It also includes a description of environmental monitoring programs based on pathway analysis, critical pathways, waste composition and properties, radiation dosimetry, regulatory standards, and site and area characteristics used to determine sampling location and frequency. Discussions include procedures used to determine where, when, and how often monitoring of specific environmental media should be conducted; environmental sample collection and general measurement techniques; statistical considerations; quality assurance; data evaluation and reporting. Detailed information is included for the following: pathway analysis; hydrological measurements; well construction; atmospheric dispersion models; dosimetric quantities; a review of the Nuclear Regulatory Commission's Licensing Requirements for Land Disposal of Radioactive Waste, the Department of Energy's Low-Level Waste Order 5820.2A, the Environmental Protection Agency's Resource Conservation and Recovery Act regulations and methods of classical statistics. 45 refs., 15 figs., 27 tabs.

21468 (DOE/LLW–13Tg-Rev.2-Vol.2) **Low level waste management handbook series: Environmental monitoring for low level waste disposal sites: Appendices: Revision 2.** EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 261p. Sponsored by U.S. DOE Defense Programs; U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90008009. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This document reviews the purpose, objectives, principles, and design of environmental monitoring programs for low-level radioactive waste disposal sites. It also includes a description of environmental monitoring programs based on pathway analysis, critical pathways, waste composition and properties, radiation dosimetry, regulatory standards, and site and area characteristics used to determine sampling location and frequency. Discussions include procedures used to determine where, when, and how often monitoring of specific environmental media should be conducted; environmental sample collection and general measurement techniques; statistical considerations; quality assurance; data evaluation and reporting. Detailed information is included for the following: pathway analysis; hydrological measurements; well construction; atmospheric dispersion models; dosimetric quantities; a review of the Nuclear Regulatory Commission's Licensing Requirements for Land Disposal of Radioactive Waste, the Department of Energy's Low-Level Waste Order 5820.2A, the Environmental Protection Agency's Resource Conservation and Recovery Act regulations and methods of classical statistics. Volume II contains only appendices. 33 figs., 9 tabs.

21469 (DOE/OR/00033–T435) **An assessment of high-level radioactive waste disposal for advanced reactor fuel cycles.** Hollaway, W.R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Nuclear Engineering. c May 1989. 233p. Sponsored by U.S. DOE Nuclear Energy; Oak Ridge Associated Universities. Available from Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139.

A preliminary comparative assessment is made of the high-level radioactive waste disposal aspects of four alternative reactor systems: the current generation domestic Light Water Reactor (LWR) system, as a reference case, and three advanced reactor systems - the Integral Fast Reactor (IFR), the Prismatic Fuel Modular Gas-Cooled Reactor (MGR-PF), and the Pebble Bed Modular Gas-Cooled Reactor (MGR-PB). The four alternative reactor systems are described, in general, and the aspects and parameters of each which are important to high-level waste disposal are developed, in detail. The method of investigation applied in this thesis is an abridged form of the multiattribute utility analysis used by the US DOE for the evaluation of candidate repository sites. However, no attempt is made to combine the results for each waste disposal impact, via value tradeoffs, into a cumulative overall single score. The primary conclusions are that, with respect to high-level radioactive waste disposal, the IFR is superior to the other systems due primarily to its small waste volume and the low actinide concentration in its HLW; and that the LWR is slightly superior to both the MGR-PF and the MGR-PB, due primarily to the large MGR waste volume per kWhre. High-level waste disposal impacts for the MGR-PF and the MGR-PB appear to be roughly equivalent. 54 refs., 46 figs., 19 tabs.

21470 (DOE/OR/00033–T436) **Cost and uncertainty optimized design of performance-prediction experiments for a nuclear waste container.** Hogan, P.M. Massachusetts Inst. of Tech., Cambridge, MA (USA). c Jun 1989. 195p. Sponsored by U.S. DOE Nuclear Energy; Oak Ridge Associated Universities. DOE Contract AC05-76OR00033. Available from Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139.

A methodology has been developed to aid in the design of experiments that will provide data to be used in the prediction of the performance of nuclear waste containers. The experiments designed by the methodology are optimized with regards to both the reduction of the data-related uncertainty associated with performance-prediction and the cost of performing the experiments. The container degradation mode specifically addressed is that of general corrosion. 19 refs., 22 figs., 4 tabs.

21471 (DOE/OR/21548–063-Rev.1) **Temporary storage area characterization report: Revision 1.** MK-Ferguson Co., St. Charles, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Jan 1990. 237p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90007843. Available from NTIS, PC A11/MF A01; OSTI; INIS.

The preferred alternative identified in the Remedial Investigation/Feasibility Study (RI/FS) for the Weldon Spring Quarry Bulk Wastes is to remove the wastes from the quarry and transport them by truck to temporary storage facility at the chemical plant site. To support the RI/FS, this report provides data to characterize the temporary storage area (TSA) site and to ensure the suitability of the proposed location. 31 refs., 14 figs., 7 tabs.

21472 (DOE/OR/21548–066) **Remedial investigations for quarry bulk wastes: Revision 1.** MK-Ferguson Co., St. Charles, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Dec 1989. 347p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90007863. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy proposes, as a separate operable unit of the Weldon Spring Site Remedial Action Project, to remove contaminated bulk wastes from the Weldon Spring quarry and transport them approximately four miles to the chemical plant portion of the raffinate pits and chemical plant area. The wastes will

be held in temporary storage prior to the record of decision for the overall remedial action. The decision on the ultimate disposal of these bulk wastes will be included as part of the decision for management of the waste materials resulting from remedial action activities at the raffinate pits and chemical plant area. 86 refs., 71 figs., 83 tabs.

21473 (DOE/OR/21548–104) **Feasibility study for management of the bulk wastes at the Weldon Spring quarry, Weldon Spring, Missouri.** Argonne National Lab., IL (USA). Feb 1990. 252p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90008115. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE), under its Surplus Facilities Management Program, is responsible for conducting remedial actions at the Weldon Spring site in St. Charles County, Missouri. The Weldon Spring site, which is listed on the National Priorities List of the US Environmental Protection Agency (EPA), became contaminated as a result of processing and disposal activities that took place from the 1940s through the 1960s. The site consists of a quarry and a chemical plant area located about 6.4 km (4 mi) northeast of the quarry. The quarry is surrounded by the Weldon Spring Wildlife Area and is near a well field that constitutes a major source of potable water for St. Charles County; the nearest supply well is located about 0.8 km (0.5 mi) southeast of the quarry. From 1942 to 1969, the quarry was used for the disposal of various radioactively and chemically contaminated materials. Bulk wastes in the quarry consist of contaminated soils and sediments, rubble, metal debris, and equipment. As part of overall site remediation, DOE is proposing to conduct an interim remedial action at the quarry to manage the radioactively and chemically contaminated bulk waste contained therein. 105 refs., 33 figs., 42 tabs.

21474 (DOE/OR/21548–105) **Proposed plan for the management of bulk wastes at the Weldon Spring quarry, Weldon Spring, Missouri.** Argonne National Lab., IL (USA). Feb 1990. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548;W-31109-ENG-38. Order Number DE90007866. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This proposed plan addresses the management of contaminated bulk wastes at the Weldon Spring quarry. Activities at the site are being conducted by the US Department of Energy under its Surplus Facilities Management Program. A remedial investigation/feasibility study has been prepared in accordance with requirements of the Comprehensive Environmental Response. The purposes of the proposed plan are to present a notice and brief analysis of the proposed quarry bulk waste remedial action, describe the remedial action alternatives for this interim remedial action, identify the currently preferred alternative for managing the bulk wastes and present the rationale for this preference, serve as a companion document to the RI/FS and administrative record file for this action, and outline the public's role in the decision-making process for this action. 2 figs., 4 tabs.

21475 (DOE/RL–89-23) **Defense Decontamination and Decommissioning Program: Program management plan.** USDOE Richland Operations Office, WA (USA). Dec 1989. 265p. Sponsored by U.S. DOE Defense Programs. Order Number DE90007812. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) Office of Defense Waste and Transportation Management (DWTM), through the Defense Decontamination and Decommissioning (D&D) Program, is responsible for the caretaking and disposition of inactive, DOE-owned or -sponsored nuclear facilities that have been declared excess after use in national defense programs. Included are shutdown nuclear reactors, chemical processing plants, waste treatment systems, laboratories, feed materials and production plants, uranium enrichment facilities, and support facilities. To ensure control of contamination until D&D is completed, it is necessary to continue routine surveillance and maintenance (S&M) of the aging structures. Because the cost of S&M increases as the shutdown facilities deteriorate, the Defense D&D Program develops and implements decommissioning plans that are both practical and cost effective. Disposition alternatives range from decontamination of a facility to allow reuse of the structure to complete dismantlement of all structures and restoration of the site for unrestricted use. 7 figs., 4 tabs.

21476 (DOE/RL–90-12) **Request for interim approval to operate 218-E-12B Trench 94 as a chemical waste landfill for disposal of polychlorinated biphenyl wastes in submarine reactor compartments.** USDOE Richland Operations Office, WA (USA). Feb 1990. 63p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008295. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This request is submitted to seek interim approval to operate a chemical waste landfill for the disposal of polychlorinated biphenyl (PCB) wastes. This request covers only the disposal of small quantities of solid PCB wastes contained in decommissioned submarine reactor compartments (SRC). The request applies only to disposal of wastes at the Hanford Site. 14 figs.

21477 (DOE-RW–89.012) **Progress report for 1987/88 from the Waste Treatment and Disposal Working Party covering joint BNFL/DoE funded work.** Claxton, D.G.S.A. (British Nuclear Fuels Ltd., Risley (UK)). Department of the Environment, London (UK). Mar 1989. 82p. (ILWRP–88-P1-13). Order Number DE90620401. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The objectives of the programme where to evaluate potential waste products arising from the conditioning of intermediate-level radioactive wastes/high-level radioactive wastes, and to develop appropriate techniques which could be used to check the quality of the finished waste product. (author).

21478 (DOE-RW–89.036) **The detection of boundaries in leaky aquifers.** Cook, A.J. (British Geological Survey, Keyworth (UK). Fluid Processes Research Group). Department of the Environment, London (UK). Jan 1989. 65p. Contract PECD-7/9/367. (FLPU–87-6). Order Number DE90620402. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Geological faults in sedimentary basins can affect the regional and local groundwater flow patterns by virtue of their enhanced permeability properties. Faults can be regarded as vertical flow boundaries and potentially important routes for radionuclide migration from a theoretical radioactive waste repository. This report investigates the hydraulic testing methods currently available which may be used to locate vertical hydraulic discontinuities (boundaries) within an aquifer. It aims to define the theoretical limitations to boundary detection by a single pumping test, to determine the optimum design of a pumping test for locating boundaries, and to define the practical limitations to boundary detection by a pumping test. (author).

21479 (DOE-RW–89.063) **Optimisation of treatment, storage and disposal strategies for (unconditioned and conditioned) radioactive waste: (Disposals II).** Bealby, J. Principia Mechanica, London (UK). Mar 1989. 51p. Contract BPECD-7/9/432. Order Number DE90620390. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This study examines the trade-offs involved between unconditioned and conditioned waste storage, by investigating the effects of different cost and environmental minimisation strategies on radioactive waste treatment and disposal strategies. The costs and environmental impacts from storage (unconditioned and conditioned), conditioning, transport and disposal are examined. A single generic mixed Magnox/AGR site is investigated, assuming a moderate nuclear power growth scenario over the period 1986 to 2030. Assessments have been performed for four weighting sets which cover the range of views perceived to exist about the relative importance of cost and environmental impact reduction. The base case conditioning option considers the availability of a LLW low force compaction plant in 1986 and two ILW conditioning plants (cement encapsulation and dissolution) in 1990. A base case set of disposal options considers the options of disposal to shallow land and burial facility and deep cavity facilities. The study investigates the effect of deferring the opening dates of the conditioning plants. A set of sensitivity studies show that the assessments are robust to the assumptions and impact parameters used. (author).

21480 (DOE/RW–0263) **OCRWM [Office of Civilian Radioactive Waste Management] System Engineering Management Plant (SEMP).** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Feb 1990. 42p. Sponsored by

U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

The Nuclear Waste Policy Act of 1982 established the Office of Civilian Radioactive Waste Management (OCRWM) in the Department of Energy (DOE) to implement a program for the safe and permanent disposal of spent nuclear fuel and high-level radioactive waste. To achieve this objective, the OCRWM is developing an integrated waste-management system consisting of three elements: the transportation system, the monitored retrievable storage (MRS) facility, and the mined geologic disposal system (MGDS). The development of such a system requires management of many diverse disciplines that are involved in research, siting, design, licensing, and external interactions. The purpose of this Systems Engineering Management Plan (SEMP) is to prescribe how the systems-engineering process will be implemented in the development of the waste-management system. Systems engineering will be used by the OCRWM to manage, integrate, and document all aspects of the technical development of the waste-management system and its system elements to ensure that the requirements of the waste-management program are met. It will be applied to all technical activities of the OCRWM program. It will be used by the OCRWM (1) to specify the sequence of technical activities necessary to define the requirements the waste-management system must satisfy, (2) to develop the waste-management system, can be optimized to most effectively satisfy the requirements. Furthermore, systems engineering will be used in the management of Program activities at the program, program-element, and project levels by specifying procedures, studies, reviews, and documentation requirements. 9 refs., 1 fig.

21481 (DP–1777) **High level radioactive waste: Doing something about it.** Wicks, G.G.; Bickford, D.F. Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab. Mar 1989. 66p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. Order Number DE90008123. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In addition to a growing inventory of spent power reactor fuel, there are approximately 100 million gallons of high-level radioactive waste [HLW] containing more than one billion curies of radioactivity stored in the United States today. This waste has been generated mainly from the production of plutonium and tritium and is primarily located on three federal sites. The waste is most often handled and stored in a liquid or semi-liquid form and placed in large underground tanks. Many of these tanks are past their projected lifetimes and consequently, some leaks have developed. Although no injuries from radiation have occurred as a result of current practices, this situation is no longer acceptable. A better way to handle the waste is needed and must be instituted as soon as possible. The strategy for long-term management of HLW will shift from a policy of temporarily storing the waste in a relatively mobile liquid form to one of using advanced technology for immobilizing radionuclides into inert solid waste products. The current program involves removing the waste from temporary storage tanks, chemically processing the waste and then immobilizing the radionuclides into borosilicate glass. The first 'glassification' or vitrification facility in the US is now over 90% complete and is scheduled to begin check-out operations early next year (1990). The waste glass produced will then be disposed of in deep geologic burial at a federal repository. Once underground, the waste glass will become part of a multi-barrier isolation system, designed to safely and effectively isolate potentially hazardous radionuclides for all generations yet to come. 132 refs., 32 figs., 2 tabs.

21482 (EEG–4) **Review comments on the report of the Steering Committee on Waste Acceptance Criteria for the Waste Isolation Pilot Plant.** Little, M.S. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div. Feb 1980. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309;AC04-78AL10752. Order Number DE90007633. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed Federal radioactive Waste Isolation Pilot Plant (WIPP) near Carlsbad, in order to protect the public health and safety and ensure that there is no environmental degradation. Analyses are conducted of reports issued by the US Department of Energy (DOE) and its contractors, other Federal agencies and other organizations, as they relate to the potential health, safety and environmental impacts from WIPP. 4 refs.

21483 (EEG–8) **The significance of certain Rustler aquifer parameters for predicting long-term radiation doses from WIPP [Waste Isolation Pilot Plant].** Wofsy, C. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div. Sep 1980. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309;AC04-78AL10752. Order Number DE90007632. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Reprinted Aug 1989.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the Waste Isolation Pilot Plant (WIPP), a Federal radioactive waste repository proposed for construction underground in an area near Carlsbad, New Mexico. The objective of the EEG evaluation is to protect the public health and safety and ensure that there is no environmental degradation. 9 refs., 4 figs., 2 tabs.

21484 (EEG–9) **An approach to calculating upper bounds on maximum individual doses from the use of contaminated well water following a WIPP [Waste Isolation Pilot Plant] repository breach.** Spiegler, P. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div. Sep 1981. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309;AC04-78AL10752. Order Number DE90007631. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the Waste Isolation Pilot Plant (WIPP), a Federal radioactive waste repository proposed for construction underground in an area near Carlsbad, New Mexico. The objective of the EEG evaluation is to protect the public health and safety and ensure that there is no environmental degradation. 14 refs., 2 figs., 8 tabs.

21485 (EEG–22) **EEG review comments on the geotechnical reports provided by DOE to EEG under the stipulated agreement through March 1, 1983.** New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group. Apr 1983. 268p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-78AL10752. Order Number DE90007634. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The purpose of the Environmental Evaluation Group is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed federal radioactive Waste Isolation Pilot Plant near Carlsbad, in order to protect the public health and safety and ensure that there is minimal environmental degradation. Analyses are conducted of available data concerning the proposed site, the design of the repository, its planned operation, and its long-term stability. 9 refs.

21486 (EEG–24) **Potential problems from shipment of high-curie content Contact-Handled Transuranic (CH-TRU) waste to WIPP [Waste Isolation Pilot Plant].** Neill, R.H.; Channell, J.K. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group. Aug 1983. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309. Order Number DE90007635. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed federal radioactive Waste Isolation Pilot Plant (WIPP) near Carlsbad, in order to protect the public health and safety and ensure that there is minimal environmental degradation. Analyses are conducted of available data concerning the proposed site, the design of the repository, its planned operation, and its long-term stability. 22 refs., 1 fig.

21487 (EEG–25) **Occurrence of gases in the Salado formation.** Chaturvedi, L. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div. Mar 1984. 75p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309;AC04-78AL10752. Order Number DE90007370. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The impetus for this study was provided by a recent series of incidents at the Kerr-McGee mine near Carlsbad, New Mexico. On December 13, 1983, a miner operating a continuous mining machine apparently hit a pocket of trapped, pressurized gas. The sudden release of pressure from this gas pocket caused the gas to expand. This resulted is dislodging of rock and debris and loose fixtures on the mining machine. According to a preliminary investigation by MSHA, "The operator of the continuous miner was apparently killed as a result of being struck by a light fixture which had been torn loose from the continuous miner and hurled back into the victim's face." Two more incidents, fortunately non-fatal, within a 5 week period in the same mine have resulted in a concern about the possibility of the occurrence of such blowouts in the WIPP excavations. The blowouts occurred 9 miles north of the center of the WIPP site in a geological strata which is 660 ft above the excavations for the WIPP repository. This study uses the reported encounters of gas in the potash mines as well as the studies related to the WIPP project as valuable information to reach some tentative conclusions about the possibility of such a hazard existing at the WIPP excavations. The conclusions of this study do not relate specifically to the safety conditions at any given mine and make no judgements about incidents in the mines. 17 refs., 11 figs., 3 tabs.

21488 (EGG-M–89442) **PREPP [Process Experimental Pilot Plant] operating experience and status.** Ball, L.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. (CONF-8910364–1: International technology exchange program conference, Mito (Japan), 17-20 Oct 1989). Order Number DE90007015. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Process Experimental Pilot Plant (PREPP) is a rotary kiln incineration facility being developed at the Idaho National Engineering Laboratory (INEL) to thermally treat contact handled Transuranic (TRU) and mixed hazardous wastes. The majority of the TRU waste will be certified and shipped directly to the Waste Isolation Pilot Plant (WIPP) for disposal. PREPP's mission is to process uncertifiable TRU and low level mixed waste, about half of the waste stored at INEL. This document discusses the planning of PREPP. Included are a PREPP system description, process modifications in process, the plutonium monitoring system, and a criticality control plan. 6 figs.

21489 (EGG-M–89471) **Applicability of the Resource Conservation and Recovery Act land disposal restrictions on small quantity generators.** Hutchison, D.P. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 2p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC07-76ID01570. (CONF-8911170–1: Host State Technical Coordinating Committee meeting, Gaithersburg, MD (USA), 15-17 Nov 1989). Order Number DE90007017. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Under Resource Conservation and Recovery Act (RCRA), there are two categories of small quantity generators. They are: (a) small quantity generators and (b) conditionally exempt small quantity generators. Presently, small quantity generators are subject to limited generator requirements but are subject to all requirements of the RCRA land disposal restrictions. Conditionally exempt small quantity generators are not subject to any of the RCRA provisions except waste determination and designation. The following provides a discussion on the applicability of the land disposal restrictions (LDR) to small quantity generators and conditionally exempt small quantity generators.

21490 (GAO/RCED–89-66) **Nuclear waste: Termination of activities at two sites proceeding in an orderly manner.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. 1989. 18p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

This report discusses how the Department of Energy's efforts to terminate nuclear waste repository program activities at sites in Washington and Texas appear to have been consistent with a reasonable interpretation of the 1987 amendments to the Nuclear Waste Policy Act. Specifically, with the exception of continuing operation of a seismic network at one site that provides information useful to other DOE programs, site-specific activities appear have been terminated within the allowable time period; no basis to conclude that site-specific activities have been continued as general research was found; and the total cost to phase out all work at the two sites is estimated to be about $116 million, or about $25 million less than the original estimate.

21491 (IVO-A–01/89) **Reliability importance measures and their calculation.** Andsten, R.; Vaurio, J.K. Imatran Voima Oy (IVO), Helsinki (Finland). Jan 1989. 43p. Order Number DE90620391. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The importance of a component to the system reliability or availability and to the system failure rate can be measured by a number of importance measures. Such measures can be used to guide the system design improvement actions as well as the diagnostic and repair actions. This report develops relationships between several importance measures, illustrates their meaning with interpretations and applications, and describes the computer program called IMPO that calculates importance measures when the system minimum cat sets and component parameters are given. A user's manual is included with illustrative examples.

21492 (JAERI-M–89-156) **Analysis of water movement and radionuclide migration in the backfill soil as an engineered barrier.** Shimooka, Kenji (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 67p. (In Japanese). Order Number DE90759922. Available from NTIS (US Sales Only), PC A04/MF A01.

It is important to understand the movement behavior of water and radionuclide migration through soil formation (saturated and unsaturated zone) which is expected as one of the engineered barriers and also natural barrier, for the safety evaluation of final storage and disposal of low level radioactive wastes come from nuclear power plants. The barrier performance tests of the soil were carried out in concrete pits as a part of 'Safety demonstration test of engineered barrier system'. One of the tests was carried out in the concrete pit B-1 by suppling radioactive solution on the surface of the backfill soil, the other was in the pit B-2 in which the simulated solidified wastes were burried in the backfill soil. A water, equivalent amount of rainfall was sprinkled for two years over the backfill soil in the concrete pits. Based on the experimental results, water movement and radionuclide migration through backfill soil were analysed. Method of the analysis and the analyzed results as well as the experimental results were described in the report. Euler-Lagrange method described in the report was confirmed to be effective simulation method for the migration of ^{137}Cs, ^{90}Sr and ^{60}Co through the backfill soil. (author).

21493 (JAERI-M–89-181) **Performance test on testing apparatus for radionuclide migration on ground surface.** Mukai, Masayuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Yamamoto, Tadatoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 58p. (In Japanese). Order Number DE90759929. Available from NTIS (US Sales Only), PC A04/MF A01.

Testing apparatus for radionuclide migration on ground surface was constructed to study the radionuclide migration on ground surface which is one of radionuclide migration paths in a natural barrier. The apparatus is composed of inflow section of solution, testing section of soil sample, outflow section of effluent solution, measurement section of water velocity, measurement section of water content et al., which can test the soil sample taken from natural field undestructively. As performance tests, four tests were carried out for each section and over all test was also carried out to confirm the linking of each section on the operation of the apparatus under actual test condition. From the performance test, it is confirmed that each section accomplishes the prescribed performance of the apparatus. As to water velocity on ground surface

and water content in soil, which are important parameters to analyze the behavior of radionuclide migration, it is confirmed that sufficient information can be obtained about the distribution of surface water velocity and the infiltration of surface water, from the measurement test of each section and the overall test. (author).

21494 (Juel-Conf–77, pp. 359-367) **Synthesis and microstructural examination of SYNROC B.** Ceh, M. (Institut Jozef Stefan, Ljubljana (Yugoslavia)); Kolar, D. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Sintering of Synroc B was carried out at 900deg C for 4 hours and at 1280deg C for 4 hours in an Ar/4%H_2 flow. The densities obtained were 95% of the theoretical density for undoped Synroc B and 93% for doped Synroc B with 10 wt% of PW-4b simulated radioactive waste. When 10 wt% of simulated radioactive waste is added to the original Synroc B material, two new phases develop in the microstructure. One phase is the intermetallic compound MoNi with Fe in solid solution, and the other phase is $(Ca,Sr)(Al,Fe)_{12}O_{19}$, a compound isostructural with magnetoplumbite. Leach tests were performed on polished specimens according to the MCC-1 standard leach test. Normalized elemental loss per unit area was calculated for Fe, Ni, Mo, Sr and U. The values obtained can be compared to the values given in the literature. (orig.).

21495 (LA-UR–90-371) **Basaltic volcanic episodes of the Yucca Mountain region.** Crowe, B.M. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–34: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007548. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The purpose of this paper is to summarize briefly the distribution and geologic characteristics of basaltic volcanism in the Yucca Mountain region during the last 10–12 Ma. This interval largely postdates the major period of silicic volcanism and coincides with and postdates the timing of major extensional faulting in the region. Field and geochronologic data for the basaltic rocks define two distinct episodes. The patterns in the volume and spatial distribution of these basaltic volcanic episodes in the central and southern part of the SNVF are used as a basis for forecasting potential future volcanic activity in vicinity of Yucca Mountain. 33 refs., 2 figs.

21496 (LA-UR–90-701) **Remediation of contaminated soil using heap leach mining technology.** York, D.A.; Aamodt, P.L. Los Alamos National Lab., NM (USA). 1990. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900553–1: Western regional symposium on mining and mineral processing wastes, Berkeley, CA (USA), 30 May - 1 jun 1990). Order Number DE90007510. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Los Alamos National Laboratory is evaluating the systems technology for heap treatment of excavated soils to remove and treat hazardous chemical and radioactive wastes. This new technology would be an extrapolation of current heap leach mining technology. The candidate wastes for treatment are those organic or inorganic (including radioactive) compounds that will chemically, physically, or biologically react with selected reagents. The project would start with bench-scale testing, followed by pilot-scale testing, and eventually by field-scale testing. Various reagents would be tried in various combinations and sequences to obtain and optimize the desired treatment results. The field-scale testing would be preceded by site characterization, process design, and equipment selection. The final step in this project is to transfer the systems technology to the private sector, probably to the mining industry. 6 refs., 1 fig.

21497 (LBL–27338) **Intermediate-field transport of contaminants: Multiple areal sources in fractured rock and point sources in porous rock.** Ahn, J. (Tokyo Univ. (Japan)); Kim, C.L.; Chambre, P.L.; Pigford, T.H.; Lee, W.W.L. Lawrence Berkeley Lab., CA (USA). Jun 1989. 11p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (UCB-NE–4154). Order Number DE90008051. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report is about "intermediate-field" transport or the migration of contaminants from arrays of discrete waste packages or sources. In constructing nuclear waste repositories in rock, it may be necessary to place a waste package across a rock fracture, or a rock fracture may develop some time after waste packages have been emplaced. To predict the spatial and temporal distribution of contaminant species from a line of waste packages facing a rock fracture may be important, because such fractures may now be considered a preferential pathway for released radionuclides to reenter the biosphere. In land disposal of hazardous wastes, individual barrels may contain especially toxic material whose dispersion special attention. We have published analytic solutions for the multidimensional advective transport of contaminants from arrays of waste packages and multiple areal sources into a planar fracture. The results show a near region in which the concentrations vary greatly in the direction transverse to ground-water flow, an intermediate region in which the array can be treated as an infinite plane source of dissolving species, and a far-field region in which the array can be treated as a plane source of finite extent. The array equations have been developed for both porous and fractured media. In this paper we summarize and compare the work with multiple areal sources facing a planar fracture and an array of point sources in porous media. 5 refs., 5 figs.

21498 (LBL–27401) **Transient diffusion from a waste solid into water-saturated, fractured porous rock.** Ahn, J. (Tokyo Univ. (Japan)); Chambre, P.L.; Pigford, T.H.; Lee, W.W.-L. Lawrence Berkeley Lab., CA (USA). Sep 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891008–5: International symposium on safety assessment of radioactive waste repositories, Paris (France), 9-12 Oct 1989). Order Number DE90007769. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Numerical illustrations for transient mass transfer from an infinitely long cylinder intersected by a planar fracture are shown based on Chambre's exact analytical solutions. The concentration at the cylinder surface is maintained at the solubility. In the fracture contaminant diffuses in the radial direction. In the rock matrix three-dimensional diffusion is assumed in the cylindrical coordinate. No advection is assumed. Radioactive decay and sorption equilibrium are included. Radioactive decay enhances the mass transfer from the cylinder. Due to the presence of the fracture, the mass flux from the cylinder to the rock matrix becomes smaller, but the fracture effect is limited in the vicinity of the fracture in early times. Even though the fracture is assumed to be a faster diffusion path than the rock matrix, the larger waste surface exposed to the matrix and the greater assumed matrix sorption result in greater release rate to the matrix than to the fracture. 8 refs., 4 figs.

21499 (LBL–28015) **Calculation of thermodynamic properties for monomeric U(IV) hydrolysis products at 298.15 K and zero ionic strength.** Phillips, S.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008053. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Critical evaluation of selected experimental data in noncomplexing electrolyte for three hydrolysis products is presented. These data were analyzed by linear regression to obtain the Gibbs energy and enthalpy of formation, entropy and heat capacity for these aqueous species. The resulting property values for the five hydrolytic species are consistent with the 1989 CODATA Key Values, and reproduce selected experimental data within the uncertainty of the measurements. 34 refs., 2 figs., 5 tabs.

21500 (LBL–28316) **The application of vertical seismic profiling and cross-hole tomographic imaging for fracture characterization at Yucca Mountain.** Majer, E.L.; Peterson, J.E.; Tura, M.A.; McEvilly, T.V. Lawrence Berkeley Lab., CA (USA). Jan 1990. 11p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–39: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number

DE90007771. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In order to obtain the necessary characterization for the storage of nuclear waste, much higher resolution of the features likely to affect the transport of radionuclides will be required than is normally achieved in conventional surface seismic reflection used in the exploration and characterization of petroleum and geothermal resources. Because fractures represent a significant mechanical anomaly seismic methods using are being investigated as a means to image and characterize the subsurface. Because of inherent limitations in applying the seismic methods solely from the surface, state-of-the-art borehole methods are being investigated to provide high resolution definition within the repository block. Therefore, Vertical Seismic Profiling (VSP) and cross-hole methods are being developed to obtain maximum resolution of the features that will possible affect the transport of fluids. Presented here will be the methods being developed, the strategy being pursued, and the rational for using VSP and crosshole methods at Yucca Mountain. The approach is intended to be an integrated method involving improvements in data acquisition, processing, and interpretation as well as improvements in the fundamental understanding of seismic wave propagation in fractured rock. 33 refs., 4 figs.

21501 (LBL–28328) **Simulation of reactive chemical transport in a varying thermal field with reaction-flow coupling.** Carnahan, C.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–35: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007766. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A computer program, THCVP, simulates coupling between advective/diffusive solute transport and chemical reactions, coupling of the reactions to heat transport, and feedback from precipitation/dissolution reactions to fluid flow. A simple simulation of transport of dissolved silicic acid along a gradient of temperature shows how precipitation of quartz at low temperatures can drastically reduce advective transport of all solution components including trace contaminants. 18 refs., 4 figs.

21502 (LBL–28333) **Seismic characterization of fracture properties.** Myer, L.R. (Lawrence Berkeley Lab., CA (USA)); Hopkins, D.; Cook, N.G.W.; Pyrak-Nolte, L.J. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–36: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007759. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The purpose of this paper is to show that there is a relationship, both empirical and theoretical, between the measured seismic response, the mechanical stiffness (also referred to as specific stiffness) of fractures and their hydraulic conductivity. Laboratory measurements of the mechanical stiffness, hydraulic conductivity and seismic properties of natural fractures are summarized. A theoretical model for the amplitude and group time delay for compressional and shear waves transmitted across a single fracture is presented. Predictions based on this model are compared with laboratory measurements. Finally, the results for a single fracture are extended to multiple parallel fractures. 13 refs., 6 figs.

21503 (LBL–28358) **Combined analytical/numerical approaches to solving fluid flow problems in the unsaturated zone at Yucca Mountain.** Zimerman, R.W.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (USA). Jan 1990. 17p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–38: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007768. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Various analytical and numerical approaches are presented for the study of unsaturated flow processes in the vicinity of the Yucca Mountain, Nevada, the proposed site of an underground radioactive waste repository. Approximate analytical methods are used to study absorption of water from a saturated fracture into the adjacent rock. These solutions are incorporated into a numerical simulator as fracture/matrix interaction terms to treat problems such as flow along a fracture with transverse leakage into the matrix. An automatic fracture/matrix mesh generator is described; it allows for more efficient mesh generation for fractured/porous media, and consequently leads to large savings in computational time and cost. 21 refs., 6 figs.

21504 (LBL–28362) **Study of fractal aperture distribution and flow in fractures.** Kumar, S.; Zimmerman, R.W.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (USA). Jan 1990. 15p. Sponsored by U.S. DOE Defense Programs; U.S. Geological Survey. DOE Contract AC03-76SF00098. (CONF-900406–43: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90008387. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This study examines the roughness profiles and aperture distributions of fractures and faults by using concepts from fractal geometry. Simple models of flow of fluid in rough fractures are also discussed. A deterministic fractal representation of the roughness profile is presented which is shown to have many distinct advantages over other numerical methods, such as information compression, uniqueness and repeatability of surface simulation, retention of statistical information, and self-similarity over many scales. Also the fractal representation enables an isotropic surface and an aperture distribution to be simulated by examining a measured profile. Saturated fluid flow in fractures is then computed using a combined Navier-Stokes and Darcy equation. 14 refs., 5 figs.

21505 (MITNE–281) **Design of a high-level waste repository system for the United States.** Baeza, J.L.; Boerigter, S.T.; Broadbent, G.E.; Cabello, E.D.; Duran, V.B.; Hollaway, W.R.; Karlberg, R.P.; Siegel, M.J.; Simonson, S.A. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Nuclear Engineering. 12 May 1988. 271p. Sponsored by U.S. DOE Nuclear Energy; Oak Ridge Associated Universities. DOE Contract AC05-76OR00033. Order Number DE90007744. Available from NTIS, PC A12/MF A01; OSTI; INIS.

This report presents a conceptual design for a High Level Waste disposal system for fuel discharged by US commercial power reactors, using the Yucca Mountain repository site recently designated by federal legislation. Principal features of the resulting conceptual design include use of unit trains for periodic removal of old spent fuel from at-reactor storage facilities, buffer storage at the repository site using dual purpose transportation/storage casks, repackaging of the spent fuel from the dual purpose transportation/storage casks directly into special-alloy disposal canisters as intact fuel assemblies, without rod consolidation, emplacement into a repository of modular design, use of excavation techniques that minimize disturbance, both mechanical and chemical, to the geologic environment, a unit rail mounted vehicle for both the transportation and emplacement of the canister from the surface facilities to the underground repository, and a cost-effectiveness computer model of Yucca Mountain and an independent cost evaluation by members of the design team. 31 refs., 58 figs., 15 tabs.

21506 (NSS/G–112) **Gas evolution and migration in repositories: Current status, May 1989.** Rees, J.H. (UKAEA Harwell Lab. (UK). Chemistry Div.). United Kingdom Nirex Ltd., Harwell (UK). May 1989. 20p. Order Number DE90620403. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Significant volumes of gas will be formed in a repository due to corrosion of metallic wastes and microbial degradation of certain organic wastes. This review sets out the progress that has been made over the last year in understanding the extent of formation of gas and its migration through the near and far fields and the effects these could give rise to. Topics where information is still required are also identified. This paper updates the Current Status review prepared in early 1988 and published as NSS/G104. (author).

21507 (NSS/R–130) **Equilibrium leach testing of low level waste. Pt. 1: Effect of backfill.** Biddle, P. (UKAEA Harwell Lab. (UK). Chemistry Div.); Gale, M.D.; Godfrey, J.G.; Woodwark, D.R. United Kingdom Nirex Ltd., Harwell (UK). Feb 1989. 46p. Order Number DE90620404. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The equilibrium leach test was developed to simulate the chemical conditions in a repository after water has penetrated the near field barriers. The principal components of the repository (the waste, backfill and canister simulant) are equilibrated with water under static conditions to simulate the very low water flows likely to be encountered in the repository. The water is sampled at various times over a 1-2 year period and analysed for radionuclides. Equilibrium leach testing has now been extended to low level wastes and this report describes the effects of different backfill compositions. Later reports will deal with the effects of other variables. A series of experiments have been conducted using four different backfills with ferric floc sludge wastes in both oxidising and reducing environments. The water was sampled at 1, 3, 6 and 12 months and analysed for actinides, fission and activation products and inactive components. It was demonstrated that the activities released depended on the nature of the backfill but not very much on the redox potential of the system. Whereas fission and activation products generally reached steady state values by three months, this was not so for the actinides which had not reached a steady value even after twelve months. Initial experiments using membrane filters indicated this was partly due to the presence of colloidal material in the leachates. Similar tests for the inactive components of the leachates did not show any significant colloidal contribution from these elements except for iron and this only in a few cases. The role of these materials cannot be precluded however, since the amounts required to interact with actinides would be very small and might be difficult to detect. (author).

21508 (NSS/R–133) **The Nirex safety assessment research programme: Annual report for 1987/88.** Cooper, M.J. (UKAEA Harwell Lab. (UK). Materials Physics and Metallurgy Div.). United Kingdom Nirex Ltd., Harwell (UK). Jul 1988. 199p. Order Number DE90620405. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

This report describes progress on the Nirex Safety Assessment Research Programme in 1987/88. The programme is concerned with research into the disposal of low-level waste (LLW) and intermediate-level waste (ILW) into underground repositories. At the beginning of 1987/88 a range of techniques for measuring and modelling far-field phenomena were being applied to near-surface disposal of low-level waste in clay. However, during the year the far-field studies were redirected to consider generic geological materials of interest for deep disposal of low and intermediate-level waste, which is now the preferred option in the UK. A substantial part of the programme is concerned with the effectiveness of near-field barriers to water-borne leakage of radionuclides from cementitious repositories. Considerable progress has been made in quantifying this and laying the foundations for robust and reliable radiological assessments to be made with appropriate models. New projects have also been initiated to study the evolution and migration of gases from an underground repository and to consider the contribution of the biosphere to the retardation of radionuclides. (author).

21509 (NSS/R–141) **Post-closure resaturation of a deep radioactive waste repository.** Cox, I.C.S. (UKAEA Atomic Energy Establishment, Winfrith (UK). Petroleum Reservoir Technology Div.); Rodwell, W.R. United Kingdom Nirex Ltd., Harwell (UK). Mar 1989. 46p. Order Number DE90620406. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The post-closure resaturation of a deep radioactive waste repository has been modelled for a number of generic disposal concepts. A combination of numerical ground water flow simulations and analytical calculations has been used to investigate the variation of repository fluid pressure and degree of water saturation with time, and to determine the factors influencing resaturation times. The host rock permeability was found to be the most important determining factor. For geological environments regarded as likely for a waste repository, resaturation is predicted to be a short term process compared with gas generation and contaminant migration timescales. (author).

21510 (NSS/R–158) **STRAW: a source-term code for buried radioactive waste.** Windsor, M.E. (UKAEA Harwell Lab. (UK). Theoretical Physics Div.). United Kingdom Nirex Ltd., Harwell (UK). Apr 1989. 15p. (AERE-R–12368). Order Number DE90620407. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

STRAW (Source Term for RadioActive Waste) is a FORTRAN program which models the behaviour of long-lived nuclides in a radioactive waste repository when physical at some future time, containment is no longer effective. The physical model takes account of the sorption of nuclides onto near-field porous material, elemental solubility limits of isotopes dissolved in the pore water of the repository, chain decay, and transport of nuclides due to groundwater flow. The program uses the Harwell Subroutine DCO3AD to solve the differential equations for the various systems of nuclides which are linked together by chain decay or by solubility considerations. Single runs of the program provide output lists of concentrations and toxicities against time for each nuclide. In addition, certain input parameters can have a range of values, in which case extra output is generated summarizing the maximum toxicities achieved for each parameter value. The effect of the parameter on the toxicity can thus be assessed for each nuclide. (author).

21511 (NUREG/CR–5256) **Components of an overall performance assessment methodology.** Davis, P.A. (Sandia National Labs., Albuquerque, NM (USA)); Price, L.L.; Wahi, K.K.; Goodrich, M.T.; Gallegos, D.P.; Bonano, E.J.; Guzowski, R.V. Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management; Sandia National Labs., Albuquerque, NM (USA); GRAM, Inc., Albuquerque, NM (USA); Science Applications International Corp., Albuquerque, NM (USA). Feb 1990. 100p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–88-3020). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Both the US Environmental Protection Agency (EPA) and the US Nuclear Regulatory Commission (NRC) have promulgated regulations regarding the performance of geologic repositories for the disposal of high-level nuclear waste. Specifically, the EPA has promulgated three quantitative, postclosure requirements that apply to the entire disposal system, while the NRC's three quantitative, postclosure requirements apply only to particular subsystems of the repository. To assess compliance with all six of these quantitative requirements, the phenomena that can affect the performance of the repository, the processes by which these phenomena are produced, and the parameters associated with these processes will have to be identified and quantified. In addition, the analyses performed to assess compliance will have to be conducted in accordance with a performance assessment methodology to ensure that all regulatory criteria are addressed. A performance assessment methodology proposed by Sandia National Laboratories is composed of scenario development and screening, consequence analysis, uncertainty analysis, and sensitivity analysis. This methodology can be used to assess compliance with the EPA's and NRC's requirements. 57 refs., 18 figs.

21512 (NUREG/CR–5435) **Environmental effects on corrosion in the Tuff repository.** Beavers, J.A. (Cortest Columbus, Inc., OH (USA)); Thompson, N.G. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Cortest Columbus, Inc., OH (USA). Feb 1990. 149p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Cortest Columbus is investigating the long-term performance of container materials used for high-level waste packages as part of the information needed by the Nuclear Regulatory Commission to assess the Department of Energy's application to construct a geologic repository for high-level radioactive waste. The scope of work consists of employing short-term techniques, to examine a wide range of possible failure modes. Long-term tests are being used to verify and further examine specific failure modes identified as important by the short-term studies. The original focus of the program was on the salt repository but the emphasis was shifted to the Tuff repository. This report summarizes the results of a literature survey performed under Task 1 of the program. The survey focuses on the influence of environmental variables on the corrosion behavior of candidate container materials for the Tuff repository. Environmental variables considered include: radiation, thermal and microbial effects. 80 refs., 44 figs., 44 tabs.

21513 (NVO–334-1) **Yucca Mountain Project technical status report, April–September 1989.** USDOE Nevada Operations Office, Las Vegas, NV (USA). Yucca Mountain Project Office. Feb 1990. 116p. Sponsored by U.S. DOE Radioactive Waste Management. Order Number DE90004833. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This Yucca Mountain Project Technical Status Report (TSR) on site characterization is the first in a series of reports that will be issued at approximately six-month intervals during site characterization. Summary information on the technical status and progress of site characterization activities described in the Site Characterization Plan is reported in the TSR. In addition, progress made toward the initiation and conduct of site characterization activities is included. For this report, information on the technical progress made by Yucca Mountain Project participating organization has been compiled covering the period from April 16, 1989, through September 30, 1989. 48 refs.

21514 (ORNL/FTR–3535) **[The role of colloidal particles on the subsurface transport of contaminants]: Foreign trip report, January 31, 1990–February 9, 1990.** McCarthy, J.F. Oak Ridge National Lab., TN (USA). 22 Feb 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007487. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary purpose of this foreign travel was to attend the 10th meeting of the European Community's CoCo (colloids and complexation) Club to learn about research on groundwater colloids in Europe and inform the CoCo participants about the colloid subprogram of the US Department of Energy (DOE) Subsurface Science Program. The goal of CoCo Club research, and of the umbrella MIRAGE (MIgration of RAdionuclides in the GEosphere) Project, is to develop data and understanding necessary to complete safety assessments for licensing nuclear repositories in Europe. The emphasis of CoCo Club research is sorption of radionuclides to organic and inorganic colloidal particles. The traveler also visited the British Geological Survey (BGS) headquarters and a BGS field site. Discussions focused on development of innovative drilling equipment for minimizing aquifer disturbance, development and application of computerized resistivity tomography for aquifer characterization, and laboratory research on the role of organic matter on metal transport. The trip was successful in that the traveler obtained a comprehensive overview of European research on groundwater colloids which will help improve and focus DOE's colloid subprogram, and the traveler learned about advances in specific areas that will contribute to his own DOE-funded project.

21515 (ORNL/M–1045) **Analysis of proposed post-closure alternatives for the Bear Creek Burial Grounds.** Walter, K.; White, R.K.; Southworth, G.; O'Donnell, F.; Travis, C.; White, D. Oak Ridge National Lab., TN (USA). [1990]. 226p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90008257. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This report assesses the risks to human health and the environment posed by the Bear Creek Burial Grounds under three remedial alternatives proposed under the Closure and Post Closure Activities Project. Chapters 3, 4, and 5 present background material on the geology and hydrology of the Burial Grounds, waste disposal practices at the Burial Grounds and data on the present extent of contamination. Chapter 6 discusses the rationale for selecting the contaminants posing the greatest risks to health and the environment. The risk posed by this group of contaminants is then assessed quantitatively. Proposed remedial alternatives for the site are described in Chapter 7. Chapter 8 evaluates migration and persistence of contaminants under each of the remedial alternatives. An assessment of the risk to human health posed by the site is presented in Chapter 9, and an assessment of ecological risk is presented in Chapter 10. Chapter 11 presents a summary of the findings of this study and makes recommendations for further action. Appendixes A and B discuss the details of groundwater modeling and surface water calculations. 60 refs., 81 figs., 32 tabs.

21516 (ORNL/RASA–89/24) **Results of the independent verification of radiological remedial action at 280 South 3rd East Street, Monticello, Utah (MS00099).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007701. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1985 and 1986, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 280 South 3rd East Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 3 refs., 2 tabs.

21517 (ORNL/RASA–89/25) **Results of the independent verification of radiological remedial action at 217 South 2nd East Street, Monticello, Utah (MS00097).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007700. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1985 and 1986, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 217 South 2nd East Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 3 refs., 2 tabs.

21518 (ORNL/TM–11227) **Contingency plan for the Oak Ridge National Laboratory liquid low-level waste system.** DePaoli, S.M.; Ferrada, J.J.; Abraham, T.J.; Brown, C.H.; Lin, K.H. Oak Ridge National Lab., TN (USA). Dec 1989. 59p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90008076. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Oak Ridge National Laboratory (ORNL) is one of the major Department of Energy (DOE) facilities that performs various research and development (R & D) activities. Liquid low-level waste (LLLW) is generated in the course of this work. The primary objective of this task is to develop specific plans of action to be implemented, in the event that the storage space for the LLLW concentrate should approach the minimum value in the operational flexibility range or a problem should develop concerning storage space available for dilute LLLW. This report considers contingency plans/options in the light of six different scenarios, including "normal operation" and five others. Evaluation and prioritization of the options were carried out separately for each case. Brief discussions of these scenarios and contingency plans/options are presented. 20 refs., 14 figs., 14 tabs.

21519 (PB–90-137738/XAB) **Health assessment for US Radium-West Orange, Orange, Essex County, New Jersey, Region 2. CERCLIS No. NJD980654172. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The U.S. Radium-West Orange site is on the National Priorities List. The two-acre site was the site of the former U.S. Radium processing facility where radium extraction, production, application, and distribution may have taken place. The principal environmental

contamination at the site and the vicinity consists of isotopes of radon, radon daughters, and radium-226. The site is considered to be of public health concern, ranging from potential to imminent, depending on the individual area in question, because of the risk to human health caused by exposure to radioactive materials via inhalation of contaminated particulate and gaseous radiation, ingestion of contaminated particulate, and external exposure to gamma radiation.

21520 (PB–90-855222/XAB) **Radioactive waste disposal: Waste Isolation Pilot Plants (WIPP). March 1978-November 1989 (Citations from the NTIS data base). Report for Mar 78-Nov 89.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 106p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the Waste Isolation Pilot Plant (WIPP), a geologic repository located in New Mexico for transuranic wastes generated by the U.S. Government. Articles follow the development of the program from initial site selection and characterization through construction and testing, along with research programs on environmental impacts, structural design, and radionuclide landfill gases. Existing plants and facilities, pilot plants, migration, rock mechanics, economics, regulations, and transport of wastes to the site are also included. The Salt Repository Project and the Crystalline Repository Project are referenced in related published bibliographies. (Contains 184 citations fully indexed and including a title list.)

21521 (PNL–6450-28-HEDR) **Hanford Environmental Dose Reconstruction Project: Monthly report, February 1990.** Dennis, B.S. (comp.). Pacific Northwest Lab., Richland, WA (USA). 1990. 52p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90008369. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objective of the Hanford Environmental Dose Reconstruction Project is to estimate the radiation doses that populations could have received from nuclear operations at Hanford since 1944. The project is divided into technical tasks which address each of the primary steps in the path from radioactive releases to dose estimates. Included are source terms, environmental transport, environmental monitoring data, demographics, agriculture, and food habits, and environmental pathways and dose estimates. The source terms task will develop estimates of radioactive emissions from Hanford facilities since 1944. The environmental transport task will reconstruct the movement of radioactive materials from the areas of release to populations via the atmosphere, surface water, and ground water. The environmental monitoring task will assemble, evaluate, and report historical environmental monitoring data. The demographics, agriculture, and food habits task will develop the data needed to determine the populations that could have been affected by the releases. Population and demographic information will be developed for the general population within the study area. In addition to population and demographic data, the food and water consumption patterns and sources of food and water for these populations must be estimated since these provide a primary pathway for the intake of radionuclides. The environmental pathways and dose estimates task will use the information produced by the other tasks to estimate the radiation doses populations could have received from Hanford. 1 tab., 1 fig.

21522 (PNL–7102) **A demonstration of the applicability of implementing the enhanced Remedial Action Priority System (RAPS) for environmental releases.** Whelan, G.; Droppo, J.G. Jr.; Strenge, D.L.; Walter, M.B.; Buck, J.W. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 292p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007613. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The Remedial Action Priority System (RAPS) and the Multimedia Environmental Pollutant Assessment System (MEPAS) were developed to prioritize problems associated with potential releases of hazardous chemical and radioactive materials in a scientific and objective manner based on limited site information. This report documents the model testing efforts of the RAPS/MEPAS methodology for the atmospheric, surface water, groundwater, and exposure components. Comparisons are given of model outputs with measured data at three sites: the US Department of Energy's Mound facility in Ohio and Hanford facility in Washington, and a chromium-cadmium plating site in New York. The results show that the simulated magnitudes, spacial and temporal trends, and distributions of contaminants corresponded well with the measured data. 25 refs., 86 figs., 26 tabs.

21523 (RFP–4406) **The Terrain-Responsive Atmospheric Code (TRAC) project plan: Development of a hazardous materials dispersion modeling capability with application to ambient air monitoring network design.** Hodgin, C.R. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. Jul 1989. 31p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90007293. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Rocky Flats Plant is applying the Terrain-Responsive Atmospheric Code (TRAC) for developing a monitoring network design for airborne hazardous materials around the Rocky Flats site. This project is being implemented in response to a recent agreement between the State of Colorado and the Department of Energy. The Hazardous Materials version of TRAC (and resulting monitor sitting plan) will be developed in a series of 63 tasks which will involve modification of the TRAC model to account for continuous emissions, source configuration and hazardous materials. After testing these modifications, a long-term archival meteorological data base will be implemented and used to produce the monitoring design. 3 figs., 1 tab.

21524 (UCRL–21076) **Electrochemical corrosion studies on copper-base waste package container materials in unirradiated 0.1 N $NaNO_3$ at 95°C.** Akkaya, M. (Florida Univ., Gainesville, FL (USA)); Verink, E.D. Jr.; Van Konynenburg, R.A. Lawrence Livermore National Lab., CA (USA). May 1988. 40p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90008380. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three candidate materials were investigated in this study in terms of their electrochemical corrosion behavior in unirradiated 0.1 N $NaNO_3$ solutions at 95°C. Anodic polarization experiments were conducted to determine the passive current densities, pitting potentials, and other parameters, together with Cyclic Current Reversal Voltammetry tests to evaluate the stability and protectiveness of the passive oxides formed. X-ray diffraction and Auger Electron Spectroscopy were used for identification of the corrosion products as well as Scanning Electron Microscopy for the surface morphology studies. 2 refs., 22 figs., 2 tabs.

21525 (UCRL–100952-Rev.1) **A Lagrangian reactive transport simulator with successive paths and stationary-states: Concepts, implementation and verification: Revision 1.** Knapp, R.B. Lawrence Livermore National Lab., CA (USA). Sep 1989. 33p. Sponsored by U.S. DOE Nuclear Energy; U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-8909306–1-Rev.1: Materials Research Society conference, Boston, MA (USA), 27-30 Sep 1989). Order Number DE90007860. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A geochemical software package which models static, single-path kinetic water-rock interactions, EQ3/6 has been modified to incorporate successive-paths and stationary states under high Peclet number transport conditions in a Lagrangian reference frame. These modifications permit calculation of reactive transport with reasonable computational requirements. Results from the new option in EQ3/6 have been compared with analytical results for the simple HCl–SiO_2 system; excellent agreements were achieved. Results have also been compared with published results for a portion of the Al_2O_3–HCl–K_2O–SiO_2 system. The results are in good qualitative and, in some cases, good quantitative agreement. However, the values of some variables differ substantially; these differences can be attributed to use of a different set of Al and Si aqueous species. 16 refs., 12 figs., 3 tabs.

21526 (UCRL–101966) **Lawrence Livermore National Laboratory incinerator trial burns.** Jackson, C.S.; Heckman, R.; Felicitas, R.; Hallisey, P. Lawrence Livermore National Lab., CA (USA). Sep 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911173–2: 5. annual hazardous materials management conference, Long Beach,

CA (USA), 7-9 Nov 1989). Order Number DE90007852. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The content of this paper describes the existing incinerator trial burns conducted at Lawrence Livermore National Laboratory (LLNL). This includes the unsuccessful demonstration of Destruction and Removal Efficiency (DRE) and the subsequent modifications to allow for successful demonstration of the DRE. The unsuccessful DRE demonstration of the original trial burn centers around the selection of the Principal Organic Hazardous Constituents (POHC's), their interaction with each other, therefore the inability to accurately quantity the constituents in the feed and the stack gases. Additionally an engineering study was undertaken to improve destruction of liquid wastes in the LLNL incinerator. The study included changes in the liquid feed injection system, combustion controls and operating procedures. The engineering study focused on operating temperatures, capacities and equipment suitability using incinerator performance data obtained during the 1988 Trial Burn. The recommendations of the study were implemented and produced higher DRE levels, increased the volumetric rate of waste destruction and improved human factors for improved operator performance. 6 refs., 1 fig., 7 tabs.

21527 (UCRL–101967) **Predictive modeling for waste minimization program performance.** Heckman, R.A.; Tang, W. Lawrence Livermore National Lab., CA (USA). Sep 1989. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911173–1: 5. annual hazardous materials management conference, Long Beach, CA (USA), 7-9 Nov 1989). Order Number DE90007855. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) facility may be best described as a moderate-sized industrial park with a number of small waste generating facilities or operations served by a central waste treatment, storage and disposal facility. In response to new regulations, a formal waste minimization project was set up in early 1985. The Laboratory had an informal effort in place driven primarily by the ever-increasing cost of off-site hazardous waste disposal. In developing a methodology to effectively implement a formal waste minimization effort, it was recognized that a detailed process waste stream analysis must be undertaken for all the waste generators in order to rank these generators. For a most efficient engineering approach to optimizing a waste minimization effort, the ranked list of generators would determine the priority of the technical effort. Thus the LLNL effort involves the development of process flow sheets for each generator and the collection of detailed waste stream characteristics and generation rate data.

21528 (USGS-OFR–90-105) **Hydrologic activities of the US Geological Survey in support of the Radionuclide Migration Program, Nevada Test Site and vicinity, Nye County, Nevada, fiscal year 1987.** Scott, W.B. Geological Survey, Carson City, NV (USA). 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AI08-86NV10583. Order Number DE90008478. Available from NTIS, PC A03/MF A01; OSTI; U.S. Geological Survey, Open File Service, Denver Federal Center, Box 25425, Denver, CO 80225; GPO Dep.

Hydrologic activities during the 1987 fiscal year by the US Geological Survey in support of the radionuclide Migration Program at the Nevada Test Site are summarized in this report. These activities included monitoring ground-water levels; compiling and entering geohydrologic data into the US Geological Survey computerized ground-water data base; providing technical support to the Radionuclide Migration Committee and the Containment Evaluation Panel; and the planning, drilling, and sampling of the UE20n-1 hole. Ground-water levels were monitored continuously at 2 wells and intermittently at 36 selected wells, test holes, and emplacement holes. Selected monthly water-level measurements are listed for the continuously monitored wells and intermittent measurements are listed for the selected wells, test holes, and emplacement holes. Progress continued on four ground-water hydrology reports of the Nevada Test Site area. 2 refs., 3 figs., 6 tabs.

21529 (VCmer–123-342) **Examination advice of the location-independent environmental-impact report and advice-direction guides for the location-dependent environmental-impact report concerning storage and processing of radiactive waste.** Ministerie VROM-Voorlopige Commissie Milieu-effectrapportage Collaboration. Voorlopige Commissie voor de Milieu-effectrapportage, Utrecht (Netherlands). 24 Jan 1986. 64p. (In Dutch). Order Number DE90706056. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This document is the examination advice made by the Provisional Committee for the enivronmental-impact reporting (VCmer) in view of the decision-making in behalf of which the location-independent environmental-impact report (MER) has been drawn up. Besides the examination by the VCmer of the location-independent MER in accordance with article 41z, part 1 and 2, this document covers an advice for direction guides for the, still to be drawn up, location-dependent MER on the storage and processing of radioactive wastes produced in the Netherlands, in accordance with article 41n, part 1 of the enactment m.e.r. The MER has been drawn up in behalf of the decision-making about location, design and construction of an aboveground, temporal storage of radioactive waste for the coming 50–100 years. In the MER two scenarios are distinguished: scenario 1 in fact reflects the actual situation in which, besides the amount of low- and medium-level radioactive waste, the high-level radioactive waste from the two nuclear power plants in the Netherlands have to be taken into account. Scenario 2 includes, besides the waste production of scenario 1, an extension with regard to the waste which would be produced in a 30-year operation time of a, still to be installed, nuclear power of 2000 MWe, to be increased up to 4000 MWe eventually. In this scenario finally about three quarter of the total volume of all radioactive waste would be produced by nuclear power plants. In that case emphasis will lay upon an installation which in particular has to be appropriate for a longtime, be it still temporary, storage of radioactive waste originating, largely, from the new nuclear power plant to be build in the Netherlands.

21530 (WAESD-TR–84-0022) **Neutron shielding analysis for remote handled transuranic waste containers in facility casks at the Waste Isolation Pilot Plant.** Livingston, J.V.; Disney, R.K. Westinghouse Electric Corp., Carlsbad, NM (USA). Waste Isolation Div. Apr 1984. 110p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-86AL31950;AC04-78AL05346. Order Number DE90007621. Available from NTIS, PC A06/MF A01; OSTI; INIS.

Neutron shielding characteristics of the Waste Isolation Pilot Plant facility cask have been quantified for a variety of combinations of neutron sources and waste matrices which would potentially be handled in waste containers. The neutron attenuation and neutron environment of the waste container and the facility cask have been analyzed to ensure that the design requirement of neutron dose rate will be met under the combinations of the source and waste matrix conditions. The analyses considered the ranges of neutron source spectrum and waste matrices which combine to produce the minimum neutron shielding worth of the facility cask. One-dimensional analyses were performed with discrete ordinate transport theory methods using multigroup neutron cross section data. The results discussed in this report demonstrate the effect of source spectrum and waste container matrix on predicted neutron dose rates adjacent to the unshielded waste container and the surface of the facility cask. An evaluation of the uncertainties in predicted neutron dose rates is provided which results in an assessment of the maximum measured neutron dose rate external to the facility cask. A description of the analytical models developed, the analysis methodology, the neutron source spectra, and the detailed results are described in this report. 10 refs., 50 figs., 39 tabs.

21531 (WHC-EP–0142-3) **Groudwater maps of the Hanford Site Separations Area, June 1989.** Kasza, G.L.; Reidel, S.P.; Schatz, A.L. Westinghouse Hanford Co., Richland, WA (USA). Sep 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90007823. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The groundwater maps of the Hanford Site Separations Area, recorded June 1989, are prepared by the Environmental Engineering and Technology Function, Environmental Division, Westinghouse Hanford Company. This set of groundwater maps consists of Separations Area depth-to-water map, Separations Area water table map, and a map comparing the potentiometric

surface of the Rattlesnake Ridge confined aquifer with the water table of the unconfined aquifer. The field measurements for these maps were collected during June 1989. The Separations Area depth-to-water map depicts the measurement well locations and the depths to the water table at these locations. This map supports engineering or environmental studies which may require the approximate depth from the ground surface to the water table. On the third map, the potentiometric surface of the Rattlesnake Ridge confined aquifer is compared with the water table of the unconfined aquifer in the vicinity of West Lake, Gable Mountain Pond, and the B Pond system. The purpose of this map is to monitor the potential for aquifer intercommunication in this area. 3 figs., 1 tab.

21532 (WHC-MR–0008) **Low-level burial grounds database.** Poremba, B.E. Westinghouse Hanford Co., Richland, WA (USA). Nov 1989. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008484. Available from NTIS, PC E07/MF E02 - OSTI; GPO Dep.

This report contains 15 microfiche supplements.

This report and accompanying microfiche of the Richland Solid Waste Information Management System database (RSWIMS database) were prepared to support the preparation of the revised Low-Level Burial Grounds Dangerous Waste Permit Application. This report and the accompanying RSWIMS data base summarize information and data on radioactive solid waste stored and disposed at the Hanford Site. All data for this report is summarized from the RSWIMS database. 7 refs.

21533 (WHC-SA–0682) **Comparison of transmission and reflection Fourier transform infrared methods for the analysis of cement blends.** Rebagay, T.V.; Dodd, D.A.; Sloughter, J.P. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900311–2: 41. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, New York, NY (USA), 5-9 Mar 1990). Order Number DE90008480. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The need for a rapid and reliable method for the routine analysis of cement, fly ash, and blast furnace slag bends led to the search for a method that meets these requisites. The blends are used for the production of grout, a waste form for the disposal of low-level radioactive liquid wastes. The long-term ability of the grout to immobilize the wastes depends on the composition of the blends. Consequently, a thorough chemical characterization of the blends are required. In an earlier work at our laboratories, the transmission method using a potassium bromide (KBr) pellet was applied successfully in the analysis of blends consisting of cement, fly ash, and clays. However, this method involves time-consuming sample preparation resulting in slow turnaround for repetitive sampling. Since reflection methods do not require elaborate sample preparation, they have the potential to reduce turnaround analysis time. Neat samples may be examined making these methods attractive for quality control. This study compares the turnaround time and reliability of two reflection methods, diffuse reflectance (DR) and attenuated total reflectance (ATR), with the transmission (KBr pellet) method. 1 ref., 6 figs., 2 tabs.

21534 (WHC-SA–0715) **Resource conservation and recovery act activities for treatment, storage, and/or disposal units operating at the Hanford Site.** Price, S.M.; Geier, C.J. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–24: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007650. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The plans and approach for meeting the Resource Conservation and Recovery Act of 1976 requirements for treatment, storage, and/or disposal units operating at the Hanford Site include permitting, groundwater monitoring, and compliance assessment work. Planning has been conducted to provide a definition of permitting needs, to prioritize these needs, and to define a plan of action for their fulfillment. In addition, a permit application format has been standardized and permit applications prepared using this format. Compliance assessment work has included the completion of interim status compliance self-assessments and the development and implementation of corrective action schedules to address identified deficiencies. This paper summarizes the plans and approach for meeting the Resource Conservation and Recovery Act of 1976 (RCRA) (1) requirements for treatment, storage, and/or disposal (TSD) units operating at the Hanford Site. This paper focuses primarily on the RCRA permitting area, in particular the status of permit applications in progress. Groundwater monitoring and compliance assessment work in support of RCRA is also briefly addressed. 17 refs.

21535 (YJT–89-11) **Half-scale solidification experiment of spent ion exchange resins.** Ipatti, A. (Imatran Voima Oy (IVO), Helsinki (Finland)); Haerkoenen, H. Voimayhtioeiden Ydinjaetetoimikunta, Helsinki (Finland). Aug 1989. 53p. (In Finnish). Order Number DE90620392. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Spent ion exchange resin was solidified into three half-scale concrete containers at the Loviisa Poweer Plant in 1987. At the same time small specimens were prepared for laboratory-scale leaching experiments. The half-scale waste packages have been immersed in groundwater since September 1987. After eighteen months of underwater storage the containers are in good condition and no changes have been detected in their weights or dimensions. No radionuclides have escaped from the containers into the storage water. The laboratory-scale leaching experiments have been underway for over a year. The measured leach rates correspond well with the results of earlier experiments. The research will be continued for several years to demonstrate the long-term durability of the waste packages in the chemical conditions of an underground repository.

21536 (YJT–89-13) **Sorption and diffusion of radionuclides (C, Tc, U, Pu, Np) in rock samples under oxic and anoxic conditions.** Suksi, S. (Helsinki Univ. (Finland). Dept. of Radiochemistry (Finland)); Siitari-Kauppi, M.; Hoelttae, P.; Jaakkola, T.; Lindberg, A. Voimayhtioeiden Ydinjaetetoimikunta, Helsinki (Finland). Nov 1989. 137p. Order Number DE90620408. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Interactions of redox sensitive elements with common Finnish rocks were studied in the laboratory under oxic and anoxic conditions. Sorption and diffusion of technetium, uranium, plutonium and neptunium were studied in drill cores of granites and gneiss. Also carbon was studied under oxic conditions. Cylindrical drill core cup samples and plane surfaces sawed from drill cores were exposed for periods from six to eighteen months to synthetic ground water to which Tc-99, U-233, Pu-236, Np-237 or C-14 as $H^{14}CO_3^-$ had been added. Synthetic granitic ground water was used in all experiments. In comparative studies for uranium also carbonate rich synthetic bentonite water was used under anoxic conditions. Technetium, uranium and neptunium were transported effectively under both oxic and anoxic conditions. Transported species of these elements were found throughout the rock matrices investigated. The measured apparent diffusivities for neptinium under oxic conditions were $2.7 \times 10^{14-}$ m^2/S for tonalite and 3.0×10^{-13} m^2/S for rapakivi granite. The range of D_a-values for neptunium under anoxic conditions was $(1.4\text{-}9.6) \times 10^{-14}$ m^2/S. For uranium the range of D_a-values under oxic conditions was $(3.6\text{-}5.7) \times 10^{-14}$ m^2/S; under anoxic conditions it was $(1.1\text{-}4.3) \times 10^{-14}$ m^2/S in granite ground water and $(1.8\text{-}5.3) \times 10^{-14}$ m^2/S in bentonite water. The ranges of measured D_a-values for technetium varied $1.8x10^{-15}$-$2.3x10^{-13}$ m^2/S under oxic conditions and $2.3x10^{-15}$-$2.3x10^{-14}$ m^2/S under anoxic conditions. The migration of plutonium was slow in all samples. The range of measured apparent diffusivities of plutonium under oxic conditions was from $2.7x10^{-15}$ to $2.4x10^{-14}$ m^2/S. Under anoxic conditions the measured D_a-values were $2.7x10^{-15}$ m^2/S for rapakivi granite.

21537 Oxygen-isotope composition of ground water and secondary minerals in Columbia Plateau basalts: Implications for the paleohydrology of the Pasco Basin. Hearn, P.P. Jr. (Geological Survey, Reston, VA (USA)); Evans, J.R.; Steinkampf, W.C.; Horton, D.G.; Solomon, G.C.; White, L.D. *Geology (USA)*, 17(7): 606-610 (Jul 1989).

Concentrations of ^{18}O and deuterium in ground waters beneath the Handford Reservation, Washington State, suggest that the

meteoric waters recharging the basalt aquifers have been progressively depleted in these isotopes since at least Pleistocene time. This conclusion is supported by oxygen-isotope analyses of low-temperature secondary minerals filing vugs and fractures in the basalts, which are used to approximate the ^{18}O content of ground water at the time the mineral assemblage formed. A fossil profile of $\delta^{18}O$ values projected for ground water in a 1500 m vertical section beneath the reservation suggest that the vertical mixing of shallow and deep ground water indicated by present-day hydrochemical data was also occurring during Neogene time. These data also suggest that a unidirectional depletion of ^{18}O and deuterium recorded in Pleistocene ground waters may have extended considerably further back in time. This shift is tentatively attributed to the orographic depletion of ^{18}O associated with the progressive uplift of the Cascade Range since the middle Miocene.

0530 Environmental Aspects

Refer also to citation(s) 21459, 21460, 21461, 21465, 21467, 21468, 21470, 21472, 21475, 21481, 21482, 21483, 21484, 21485, 21486, 21487, 21496, 21497, 21500, 21504, 21512, 21513, 21515, 21518, 21521, 21522, 21523, 21528, 21529, 21531, 21532, 21534, 21539, 21541, 21542, 22450, 22545, 22546, 22584, 22599

21538 Uranium-thorium series radionuclides in brines and reservoir rocks from two deep geothermal boreholes in the Salton Sea geothermal field, southeastern California. Zukin, J.G. (Univ. of Southern California, Los Angeles (USA)); Hammond, D.E.; Ku, Tehlung; Elders, W.A. *Geochimica et Cosmochimica Acta (USA)*, 51(10): 2719-2731 (Oct 1987). DOE Contract AC02-83CH10140.

Naturally occurring U and Th series radionuclides have been analyzed in high temperature brines (~ 300°C, 25 wt% dissolved solids) and associated rocks from two deep geothermal wells located on the northeastern margin of the Salton Sea Geothermal Field (SSGF). These data are part of a study of the SSGF as a natural analog of possible radionuclide behavior near a nuclear waste repository constructed in salt beds, and permit evaluation of some characteristics of water-rock interaction in the SSGF.

0540 Health and Safety

Refer also to citation(s) 21448, 21464, 21465, 21471, 21473, 21474, 21475, 21482, 21483, 21484, 21488, 21496, 21515, 21516, 21517, 21522, 21534, 21804

21539 (DOE/EIS–0132-F) **Remedial actions at the former Union Carbide Corporation uranium mill sites, Rifle, Garfield County, Colorado: Final environmental impact statement: Volume 1, Text.** USDOE Albuquerque Operations Office, NM (USA). Uranium Mill Tailings Remedial Action Project Office. Mar 1990. 396p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008332. Available from NTIS, PC A17/MF A01; OSTI; INIS; GPO Dep.

This appendix provides the information needed to understand the conceptual designs for the remedial action alternatives addressed in this environmental impact statement (EIS). It is intended to provide sufficient details for the reader to evaluate the feasibility and assess the impacts of each remedial action alternative. It is not intended to provide the detailed engineering necessary to implement the alternatives. Details of the preferred remedial action will be presented in the remedial action plan (RAP). The remedial action alternatives addressed in this EIS include no action, stabilization at the New Rifle site, disposal at the Estes Gulch site, and disposal at the Lucas Mesa site. All alternatives include interim actions to remediate existing health and safety hazards to the Rifle community that presently exist at the Old and New Rifle processing sites. 21 figs., 18 tabs.

21540 (DOE/ER/60577–2) **Generation and mobility of radon in soil: Annual technical progress report, March 1987–February 1990.** Rose, A.W. Pennsylvania State Univ., University Park, PA (USA). 1990. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60577. Order Number DE90007556. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This research generation and mobility of radon in soil evaluates the extent and nature of uranium and radium depletion and/or enrichment in soil horizons as a function of climate and other factors affecting soil character; evaluates the relation of radon emanation coefficient to soil type, soil properties, soil-forming factors, and radon levels in soil gas; and evaluate the relations of fragipans, soil moisture and soil permeability to radon concentration and radon flux in soil profiles. The approach has been to investigate in detail 13 soil profiles selected to represent distinct differences in parent material (limestone, sandstone, shale, granite), major soil groups (Alfisols, Ultisol, Inceptisol, Mollisol, Spodosol), and moisture regimes (well-drained to somewhat poorly drained with fragipan). The nine profiles investigated in the first 2 years are in Pennsylvania and North Carolina. Four profiles currently being sampled are in New York, Tennessee, Illinois and Pennsylvania. Samples from five profiles in Georgia have also been analyzed in less detail. A combination of pedologic, geochemical and radiometric methods have been applied to understanding radon at these sites (Table 2). An important feature of the project has been the collaboration of a geochemist, a soil scientist and a nuclear engineer as Co-PI's. 4 refs., 12 figs., 4 tabs.

21541 (FMPC–2173) **Feed Materials Production Center environmental monitoring annual report for 1988.** Gels, G.L.; Grib, M.A.; Oberjohn, J.S. Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center. Jun 1989. 180p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-86OR21600. Order Number DE90007649. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The Department of Energy's (DOE) Feed Materials Production Center (FMPC) is involved in the processing of uranium for the nation's defense program. The FMPC also manages the storage of some radioactive and hazardous materials. As a part of its operations, the FMPC continuously monitors the environment to determine that it is operating within federal and state standards regarding emission of radiological and nonradiological materials. Data collected from the FMPC monitoring program are used to calculate estimates of radiation dose for residents surrounding the FMPC. For 1988, the estimate of dose due to FMPC operations indicated that people in the area were exposed to less than 3% of the DOE standard established to protect the public from radiation exposure. Indeed, the dose from FMPC operations during 1988 was less than 1% of what is considered the average dose each resident in the Greater Cincinnati area receives each year from naturally-occurring radiation. This annual report is a summary of the FMPC's environmental performance during 1988. An addendum to this report detailing the status of chemical releases at the FMPC will be used later this year.

21542 (FMPC/Sub–018) **Biological and ecological site characterization of the Feed Materials Production Center, June 1986–June 1987.** Facemire, C.F.; Guttman, S.I.; Osborne, D.R.; Sperger, R.H. Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center; Miami Univ., Oxford, OH (USA). Dept. of Zoology. Jan 1990. 491p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-86OR21600. Order Number DE90008771. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

This section summarizes field and laboratory studies conducted at the FMPC from June, 1986 through June, 1987. The major items to be accomplished per contract were (1) plan and lay-out permanent transects to be utilized in gathering biological and ecological data, (2) identify aquatic and terrestrial life forms within the environs of the FMPC, (3) prepare a catalog documenting the location and associated habitat of all species found, (4) determine species distribution and abundance, (5) determine the possibility of stress-induced differences between onsite and offsite plant and animal populations using electrophoretic techniques, and (6) interpret the results of the study.

21543 (ORNL/RASA–89/21) **Results of the independent verification of radiological remedial action at 433 South 2nd East Street, Monticello, Utah (MS00103).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 12p. Sponsored by

U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007704. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity)properties that had been contaminated by radioactive material resulting from mill operations. During 1984 and 1985, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 433 South 2nd East Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 2 tabs., 3 refs.

21544 (ORNL/RASA–89/22) **Results of the independent verification of radiological remedial action at 416 South Main Street, Monticello, Utah (MS00150).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007703. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1984 and 1985, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 416 South Main Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 3 refs., 2 tabs.

21545 (ORNL/RASA–89/23) **Results of the independent verification of radiological remedial action at 281 East 3rd South Street, Monticello, Utah (MS00138).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007702. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1985, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 281 East 3rd South Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 3 refs., 2 tabs.

21546 (ORNL/RASA–89/26) **Results of the independent verification of radiological remedial action at 165 North 1st West Street, Monticello, Utah (MS00014).** Crutcher, J.W.; Wilson, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90007699. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1980 the site of a vanadium and uranium mill at Monticello, Utah, was accepted into the US Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1985 and 1986, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 217 South 2nd East Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described. 3 refs., 2 tabs.

21547 (WSRC-RP–89-1298) **Data banks for risk assessment at the Savannah River Site.** Durant, W.S.; Lux, C.R.; Baughman, D.F. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-9004149–1: DOE/ANL training course on the prevention of significant nuclear events, Augusta, GA (USA), Apr 1990). Order Number DE90007119. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Site maintains a compilation of operating problems and equipment failures that have occurred in the fuel reprocessing and other areas in the form of computerized data banks. 14 refs., 25 figs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 21448, 21739, 21921, 22255

21548 (ANL–89/44) **PC-DYMAC: Personal Computer—DYnamic Materials ACcounting.** Jackson, B.G. Argonne National Lab., IL (USA). Nov 1989. 153p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. Order Number DE90008096. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This manual was designed to provide complete documentation for the computer system used by the EBR-II Fuels and Materials Department, Argonne National Laboratory-West (ANL-W) for accountability of special nuclear materials (SNM). This document includes background information on the operation of the Fuel Manufacturing Facility (FMF), instructions on computer operations in correlation with production and a detailed manual for DYMAC operation. 60 figs.

21549 (DOE/DP–0077P) **Annual report on strategic special nuclear material inventory differences.** USDOE Assistant Secretary for Defense Programs, Washington, DC (USA). Office of Safeguards and Security. Jan 1990. 29p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008039. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report of unclassified Inventory Differences (ID's) covers the twelve months from April 1, 1988 through March 31, 1989 for all key Department of Energy (DOE) and DOE contractor operated facilities possessing strategic special nuclear materials*. Classified information is not included in this report. This classified information includes data for the Rocky Flats and Y-12 nuclear weapons production facilities or facilities under ID investigation. However, classified ID data from such facilities receive the same scrutiny and analyses as the included data. The data in this report have been prepared and reviewed by DOE contractors, field offices, and Headquarters. When necessary, special investigations have been performed in addition to these reviews. The ID data, explanations, reviews, and any additional special investigations, together with the absence of physical indications of any theft attempt, support a finding that no theft or diversion of significant quantities of strategic special nuclear material has occurred in DOE facilities during the twelve-month period covered by this report.

21550 (JAERI-M–89-171) **Study of relationship between MUF correlation and detection sensitivity of statistical analysis.** Tamura, Toshiaki (Japan Atomic Energy Research Inst., Tokai,

Ibaraki (Japan). Tokai Research Establishment); Ihara, Hitoshi; Yamamoto, Yoichi; Ikawa, Koji. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 165p. (In Japanese). Order Number DE90759894. Available from NTIS (US Sales Only), PC A08/MF A01.

Various kinds of statistical analysis are proposed to NRTA (Near Real Time Materials Accountancy) which was devised to satisfy the timeliness goal of one of the detection goals of IAEA. It will be presumed that different statistical analysis results will occur between the case of considered rigorous error propagation (with MUF correlation) and the case of simplified error propagation (without MUF correlation). Therefore, measurement simulation and decision analysis were done using flow simulation of 800 MTHM/Y model reprocessing plant, and relationship between MUF correlation and detection sensitivity and false alarm of statistical analysis was studied. Specific character of material accountancy for 800 MTHM/Y model reprocessing plant was grasped by this simulation. It also became clear that MUF correlation decreases not only false alarm but also detection probability for protracted loss in case of CUMUF test and Page's test applied to NRTA. (author).

21551 (LA–11569-M, pp. 3-20) **Basic concepts of materials accounting.** Markin, J.T. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

The importance of accounting for nuclear materials to the efficient, safe, and economical operation of nuclear facilities is introduced, and the following topics are covered: material balance equation; item control areas; material balance uncertainty; decision procedures for materials accounting; conventional and near-real-time accounting; regulatory requirements of the US Department of Energy and the Nuclear Regulatory Commission; and a summary related to the development of a materials accounting system to implement the basic concepts described. The summary includes a section on each of the following: problem definition, system objectives, and system design.

21552 (LA–11569-M, pp. 21-22) **The structure of nuclear safeguards systems.** Coulter, C.A. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Safeguards systems for facilities that handle special nuclear material combine procedural, protective, and materials accounting elements to prevent and/or detect sabotage and diversion or theft of material. Because most of the discussion in this course is devoted to materials accounting topics only, this chapter provides a brief introduction to some of the procedural and protective elements of safeguards systems, placing the materials accounting system in its proper context. The chapter begins by reviewing certain pertinent DOE definitions and then surveys some protection requirements and technology - protective personnel, personnel identification systems, barriers, detectors, and communication systems. Considered next are the procedures of personnel selection and monitoring, definition and division of job functions, and operation. The chapter then describes the way the procedural, protective, and materials accounting elements can be combined, becoming a total safeguards system. Although such a system necessarily requires elements of procedure, protection, and materials accounting, only the materials accounting gives positive assurance that nuclear material is not diverted or stolen.

21553 (LA–11569-M, pp. 23-64) **Elements of nondestructive assay (NDA) technology.** Hatcher, C.R.; Smith, H.A. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

A brief history, uses, strengths and limitations, and classification of nondestructive assay techniques in the context of nuclear safeguards are given. The following topics are then covered: passive gamma-ray methods including general information, scintillation spectroscopy, semiconductor spectroscopy, and gross gamma-ray techniques; passive neutron methods including general information, passive methods that detect single neutron counts, and passive methods that detect coincident neutron counts; calorimetry; active gamma-ray and x-ray methods including absorption spectrometry and induced active response; and active neutron methods including general information, coincidence discrimination, time discrimination, and energy discrimination.

21554 (LA–11569-M, pp. 65-86) **Part one: Statistical concepts.** Picard, R.R.; Campbell, K. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Topics covered in this chapter include a discussion of variability; mean and standard deviation; precision, accuracy, and bias; normal distribution; confidence limits and confidence intervals; measurement error models; hypothesis testing; and measurement control and control charts as they relate to nuclear materials accounting and management within nuclear facilities.

21555 (LA–11569-M, pp. 87-114) **Part two: Error propagation.** Picard, R.R. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Topics covered in this chapter include a discussion of exact results as related to nuclear materials management and accounting in nuclear facilities; propagation of error for a single measured value; propagation of error for several measured values; error propagation for materials balances; and an application of error propagation to an example of uranium hexafluoride conversion process.

21556 (LA–11569-M, pp. 115-133) **Statistical decisions.** Picard, R.R. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Topics covered in this chapter include a discussion of hypothesis tests as related to the concept of nuclear materials management and accounting in nuclear facilities. Hypothesis tests related to an individual measurement, an individual material balance, and a sequence of materials balances are discussed. The discussion of a sequence of materials balances includes the innovation sequence, sequential decision making, and performance measures.

21557 (LA–11569-M, pp. 135-172) **Process holdup of special nuclear materials.** Pillay, K.K.S.; Picard, R.R. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Safeguarding special nuclear material (SNM) through materials control and accounting (MC and A) often encounters a variety of implementation problems. In materials accounting terminology, hidden inventories are part of materials unaccounted for of inventory difference. Because holdup of nuclear materials in process equipment offers unique challenges to MC and A, this topic is carefully explored in this chapter with special efforts to estimate process holdup at an example uranium conversion facility. Specific topics covered include: holdup (hidden inventory) including definition, causes, mechanisms, and magnitude; process holdup and materials accounting including past efforts and holdup and inventory difference; holdup measurements at processing facilities including plutonium on HEPA filters, uranium holdup in scrap recovery facility, and holdup of uranium in air ducts; controlled studies of SNM holdup; and modeling approaches including modeling with respect to time and space.

21558 (LA–11569-M, pp. 173-200) **Measurement control and quality assurance.** Gutmacher, R.G. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

Measurements of weight and volume, chemical and isotopic composition, and physical properties of materials are made to control a process, certify that products meet specifications, and provide regulation and accounting of special nuclear materials. It is vital that these measurements be of consistent and acceptable quality. This chapter covers the following topics: regulatory requirements; elements of a quality assurance program for measurements including organization, quality assurance program, training and

qualification of personnel, procedures, measurement records, control of records, control of equipment and materials, control and review of measurement methods, and periodic program reviews; selection and validation of measurement methods; determining and controlling measurement error including mass measurements, measurement of liquid volumes, sampling, chemical measurements, and nondestructive assay; and control charts.

21559 (LA–11569-M, pp. 201-223) **Fundamental data analyses for measurement control.** Campbell, K.; Barlich, G.L.; Fazal, B.; Strittmatter, R.B. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

An important aspect of a complete measurement control program for special nuclear materials is the analysis of data from periodic control measurements of known standards. This chapter covers the following topics: basic algorithms including an introduction and terminology, the standard case (known mean and standard deviation), Shewart control charts, and sequential test for bias; modifications for nonstandard cases including modification for changing (decaying) standard value, modifications for deteriorating measurement precision, and modifications when repeated measurements are made; maintenance information including estimation of historical standard deviation (standard case), estimation of historical standard deviation (changing with time), normality and outliners, and other tests of randomness.

21560 (LA–11569-M, pp. 225-246) **Determination of detection sensitivities of nuclear materials accounting systems.** Stirpe, D. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

An important element in safeguarding nuclear facilities against the loss of special nuclear materials (SNM) is accounting for this material through periodic measurement of all input and output transfers and inventories. This chapter covers the following topics: terms of a material balance equation; measurement errors and error models; an example problem in materials accounting concerning the design of a materials accounting system for a mixed oxide fuel fabrication line; variance calculations for material balance areas; detection sensitivity of materials accounting systems; and additional suggestions for the design of improved accounting systems.

21561 (LA–11569-M, pp. 247-263) **Materials control and accounting in a plutonium processing facility.** Barnes, J.W.; Baker, A.L.; Marr, T.G. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

This chapter discusses materials control and accounting (MC and A) as practiced in currently operating plutonium processing facilities, illustrates application of system analysis techniques, and describes some problems typically encountered in implementation of an effective MC and A system. In addition to the example process, the chapter includes the following topics: accountability measurements, materials balance equation, variance calculations, throughput effects, and unmeasured inventory (holdup).

21562 (LA–11569-M, pp. 265-301) **Survey of chemical and bulk measurement methods.** Gutmacher, R.G.; Jackson, D.D. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

The chapter discusses the following topics related to nuclear materials management and accounting: mass, volume, density, and flow measurements; sampling problems and techniques related to liquids and powders; measurement uncertainties; elemental methods of analysis including gravimetric methods, spectrophotometric methods, electrometric titration, fluorometry, x-ray fluorescence, x-ray absorption edge densitometry, alpha-spectrometric methods, and mass spectrometric methods.

21563 (LA–11569-M, pp. 313-324) **Materials accounting at Los Alamos National Laboratory.** Erkkila, B.H.; Roberts, N.J. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

This presentation gives an overview of the accounting system used at the Los Alamos National Laboratory by the Los Alamos Nuclear Material Accounting and Safeguards System (MASS). This system processes accounting data in real time for bulk materials, discrete items, and materials undergoing dynamic processing. The following topics are covered in this chapter: definitions; nuclear material storage; nuclear material storage; computer system; measurement control program; inventory differences; and current programs and future plans.

21564 (LA–11569-M, pp. 337-352) **Workshop on real-time materials accounting simulator.** Picard, R.R.; Barlich, G.L.; Hafer, J.F. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

The Real-Time Materials Accounting Simulator (RTMAS), developed as an educational tool at Los Alamos National Laboratory, investigates the relationships of a diversion scenario applied to a simple process model and materials accounting evaluation procedures used to detect diversion. The topics covered in this chapter include the process model; the measurement model; evaluation procedures; RTMAS execution; and diversion scenarios.

21565 (LA–11569-M, pp. 303-312) **A DOE (Department of Energy) view of safeguards.** Hammond, G.A. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

This chapter deals with the Department of Energy perspective as of April 1988 as well as new developments for nuclear materials control and accounting in integrated safeguards systems. Topics covered in this chapter include: a review of the mission of safeguards and security; integrated safeguards and security approach; materials control subsystem including containment and custodianship, nuclear materials detection and surveillance, confirmatory and semiquantitative measurements, and process and operations monitoring; materials accounting subsystem; independent substantiation (enhancement of assurance and overall credibility); and directions and prospects for nuclear materials management and accounting improvements.

21566 (LA–11569-M, pp. 353-376) **Workshop on materials control and accounting system design.** Pillay, K.K.S. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

The chapter describes the workshop aimed at reinforcing, through participation in the design exercise, the concepts of nuclear materials control and accountability. Topics include: workshop format; key elements of a materials management and accounting (MC and A) system; and MC and A system design including safeguards organization and management, material access areas, key measurement points, nuclear materials measurements, physical inventory, material balance closings, and internal controls. Appended to this chapter is a detailed description of a facility that produces metallic plutonium and the safeguards requirements for this facility.

21567 (LA–11569-M, pp. 325-336) **International safeguards.** Hakkila, E.A.; Hatcher, C.R.; Sapir, J.L. Los Alamos National Lab., NM (USA). Apr 1989. In *Fundamentals of materials accounting for nuclear safeguards.* Order Number DE89010766. Available from NTIS, PC A17/MF A01.

The following topics are covered in this chapter: basis for international safeguards; basis for applying international safeguards in US facilities; application of international safeguards at the facility level; and example of application of international safeguards at a low-enriched uranium fuel fabrication facility including material balance area structure and key measurement points, inspection activities, auditing operator's measurement system, verifying nuclear material, containment and surveillance measures, and inspector's conclusions.

21568 **Nondestructive assay.** Keepin, G.R. (Los Alamos National Lab., NM (USA)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 56-65 (Nov 1989).

Analytical chemistry and the physics of radiometric measurements have effected an interdisciplinary synergism into the broad field of nuclear material measurements and have given rise to nondestructive assay technology widely supporting domestic and international safeguards. The events leading up to the establishment of a safeguards R and D program and the subsequent contributions thereof to international safeguards are discussed.

21569 **Measurements and material accounting.** Hammond, G.A. (US Dept. of Energy, Office of Safeguards and Security, Washington, DC (US)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 82-84 (Nov 1989).

The DOE role for the NBL in safeguarding nuclear material into the 21st century is discussed. Development of measurement technology and reference materials supporting requirements of SDI, SIS, AVLIS, pyrochemical reprocessing, fusion, waste storage, plant modernization program, and improved tritium accounting are some of the suggested examples.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0702 Radiation Sources

Refer also to citation(s) 21693

21570 (DOE/OR/00033–T433) **Multiply-charged ion emission from a cyclotron-resonance-heated plasma ion source.** Whaley, D.R. Michigan Univ., Ann Arbor, MI (USA). Plasma Experimental Lab. May 1989. 230p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-76OR00033. Available from University of Michigan, Ann Arbor, MI 48109.

Electron cyclotron resonance heated ion sources have become the prominent electron-stripping device used to produce multiply-charged ions. These ions are required for many applications ranging from atomic physics research to cyclotron injection. Unfortunately, many of these sources are designed, built and operated based on empirical knowledge acquired from past or existing machines. Much research remains to be performed before a solid understanding of the physical processes governing these sources can be gained. The work presented here attempts to partially bridge the gap between application and understanding. A time-of-flight spectrometer diagnostic system was implemented on MIMI to measure the endloss current density for specific charge states flowing from the mirror. The method of acquiring many spectra in a given shot over a relatively short span of real time, and averaging them to produce one averaged spectrum has proven quite effective in reducing random signal fluctuations. Also, shot-to-shot reproducibility becomes possible with this method – a difficult and most welcome result. Ion cyclotron heating has been shown to increase ion temperatures tens of eV. The resonant species typically experiences the greatest temperature increase but transfers much of its energy to the remainder of the distribution via collisions. These temperature increases are consistent with those expected from antenna loading computations. Modeling of the important physical processes occurring in the plasma yields results consistent with those measured with the time-of-flight spectrometer. 62 refs., 68 figs., 9 tabs.

21571 (PB–90-130279/XAB) **Center for Radiation Research (of the National Institute of Standards and Technology) technical activities for 1989.** Kuyatt, C.E. National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Center for Radiation Research. Nov 1989. 181p. (NISTIR–89/4183). Available from NTIS, PC A09/MF A01.

See also PB–89-127294.

This report summarizes research projects, measurement method development, calibration and testing, and data evaluation activities that were carried out during Fiscal Year 1989 in the NIST Center for Radiation Research. The activities fall in the areas of radiometric physics, radiation sources and instrumentation, ionizing radiation, and nuclear physics.

0705 Health and Safety

Refer also to citation(s) 21804

08 HYDROGEN

0801 Production

21572 **Ammonia-pretreatment-induced restructuring of iron single-crystal surfaces: Its effects of ammonia synthesis and on coadsorbed aluminum oxide and potassium.** Strongin, D.R. (Univ. of California, Berkeley (USA)); Somorjai, G.A. *Journal of Catalysis (USA),* 118(1): 99-110 (Jul 1989). DOE Contract AC03-76SF00098.

The effects of ammonia pretreatment on the structure and activity of iron single-crystal surfaces for ammonia synthesis are examined. Treatment of the (110), (100), and (111) planes of iron with 5 or 50 Torr of ammonia causes surface restructuring as evidenced by changes in ammonia synthesis activity, and in temperature-programmed desorption, and by the appearance of new surfaces as seen by scanning electron microscopy. The (110) plane of iron is inactive for ammonia synthesis under the conditions used in this study, but the ammonia-pretreatment-restructured Fe(110) surface becomes about twice as active as the Fe(100) face. The restructured Fe(100) surface becomes about four times more active than the clean, unrestructured (100) surface. Restructuring the active Fe(111) face in ammonia results in a slight decrease in ammonia synthesis activity. The kinetic data, temperature-programmed desorption, and scanning electron microscopy suggest that Fe(110) and Fe(100) are restructured to surfaces containing C_7 sites, such as Fe(111) and Fe(211). A stereographic analysis of the restructured Fe(111) surface, using scanning electron microscopy, taken together with the reaction rate measurements suggests that [211] surface planes are formed upon ammonia treatment. The high concentrations of near-surface nitrogen that is deposited by the ammonia pretreatment does not block catalytic sites for the synthesis of ammonia. The presence of aluminum oxide on any of the iron single-crystal surfaces inhibits the ammonia-induced restructuring process, while the presence of potassium has no observable effect on the process. These results suggest a method of activating iron with both ammonia and water vapor restructuring in the presence of aluminum oxide and potassium to achieve a catalysts with optimal activity for ammonia synthesis.

0802 Storage, Transport, and Handling

21573 (PB–90-855727/XAB) **Hydrogen storage: Storage as a gas or liquid. January 1974-December 1989 (Citations from the NTIS data base). Report for January 1974-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 196p. Available from NTISPC N01/MF N01.

Supersedes PB–89-854400.

This bibliography contains citations concerning feasibility studies and field investigations regarding the storage of hydrogen in a liquid or gaseous phase. Topics include descriptions of specific programs undertaken by various agencies and institutions, storage methods for automotive fuels, and economic aspects. Some attention is given to materials considerations for storage tanks and transport facilities. (This updated bibliography contains 394 citations, 56 of which are new entries to the previous edition.)

0830 Combustion

21574 (N–90-14284) **Atomic hydrogen as a launch vehicle propellant.** Palaszewski, B.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 12p. (NASA-TM–102459;E–5246;NAS–1.15:102459;AIAA–90-0715;CONF-900153–: 28. AIAA aerospace sciences meeting, Reno, NV (USA), 8-11 Jan 1990). Available from NTIS, PC A03/MF A01.

An analysis of several atomic hydrogen launch vehicles was conducted. A discussion of the facilities and the technologies that would be needed for these vehicles is also presented. The Gross

Liftoff Weights (GLOW) for two systems were estimated; their specific impulses (I_{sp}) were 750 and 1500 $lb_f/s/lb_m$. The atomic hydrogen launch vehicles were also compared to the currently planned Advanced Launch System design concepts. Very significant GLOW reductions of 52 to 58 percent are possible over the Advanced Launch System designs. Applying atomic hydrogen propellants to upper stages was also considered. Very high I_{sp} (greater than 750 $lb_f/s/lb_m$) is needed to enable a mass savings over advanced oxygen/hydrogen propulsion. Associated with the potential benefits of high I(sub sp) atomic hydrogen are several challenging problems. Very high magnetic fields are required to maintain the atomic hydrogen in a solid hydrogen matrix. The magnetic field strength was estimated to be 30 kilogauss (3 Tesla). Also the storage temperature of the propellant is 4 K. This very low temperature will require a large refrigeration facility for the launch vehicle. The design considerations for a very high recombination rate for the propellant are also discussed. A recombination rate of 210 cm/s is predicted for atomic hydrogen. This high recombination rate can produce very high acceleration for the launch vehicle. Unique insulation or segmentation to inhibit the propellant may be needed to reduce its recombination rate.

09 BIOMASS FUELS

Refer also to citation(s) 22208

0907 Resources

Refer also to citation(s) 21590

21575 (DOE/OR/21390–26) **Great Lakes Regional Biomass Energy Program: Quarterly report, September 1, 1989 – November 30, 1989.** Kuzel, F. Council of Great Lakes Governors, Chicago, IL (USA). Dec 1989. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG05-83OR21390. Order Number DE90007665. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This is the first quarterly report of the seventh year of operation of the Great Lakes Regional Biomass Energy Program. The program was initiated in 1983 with a grant to the Council of Great Lakes Governors from the Biofuels and Municipal Waste Technology Division of the US Department of Energy. Stressing near-term biomass feedstock production techniques and conversion processes, the objective of the program is to increase the use of biomass energy by the public and private sectors in the seven state Great Lakes region. States that are in the Great Lakes region include: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin. The Great Lakes Regional Biomass Energy Program is divided into three separate operational programs. The first is the State Grant program, which provides resources to the seven state energy offices in the region to increase their capabilities in biomass energy. State specific activities and interagency programs are emphasized in the State Grant Program. The second, the Subcontractor program, involves the letting of subcontracts to private organizations to address regional biomass issues and needs. The third is the In-House Technology Transfer program in which Council staff develop biomass energy publications and reports. Due to reduced funding levels, this year's program contains no new subcontractor projects. Several projects initiated with prior year's funding will be completed this year.

0908 Production

Refer also to citation(s) 22710, 22714

21576 (DOE/ER/60530–3) **[Toxic organic compounds]: Progress report.** Indiana Univ. Foundation, Bloomington, IN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60530. Order Number DE90007417. Available from NTIS, PC A02/MF A01 - OSTI.

The general theme of this program has been the identification of potentially toxic organic compounds associated with various combustion effluents, following the fates of these compounds in the environment, and improving the analytical methodology for making these measurements. Over the years, Professor Hites' interest has ranged from polycyclic aromatic hydrocarbons to diesel exhaust to chlorinated dioxins. At the moment, work in his laboratory is increasingly focused on the fundamentals of mass spectrometry although he continues to be interested in environmental processes and measurements. Electron capture, negative ionization, mass spectrometry is a particularly important technique for environmental contaminant analysis. Many such contaminants contain electronegative atoms (such as chlorine); thus, negative ionization techniques provide both high specificity as well as high sensitivity. Her work focused on identifying the instrumental parameters which caused variation both within and between laboratories. It turned out that careful control of ion source lens potentials and temperature and eliminating extraneous oxygen allowed her to achieve reproducible spectra. She studied the fragmentation behavior of about 300 compounds and deduced certain rules of fragmentation. This work resulted in several papers and in a book published by VCH Press. 61 refs.

21577 (PB–90-128836/XAB) **Cyanide in MGP (manufactured gas plant) wastes: Investigation of analytical methods. Topical report, January 1988-June 1989.** Gould, J.E.; Theis, T.L.; Luthy, R.G. Atlantic Environmental Services, Inc., Colchester, CT (USA). Jun 1989. 47p. Available from NTIS, PC A03/MF A01.

Wastes associated with manufactured gas plant (MGP) sites are known to contain various cyanide complexes. Problems exist relative to evaluating the true cyanide content of these solid wastes. These problems are, in general, related to lack of standard laboratory methods for extracting and analyzing leachate or distillates from solid samples. Samples of MGP purifier wastes were analyzed by two university laboratories under carefully controlled conditions to establish absolute levels of total cyanide in the samples. Duplicate samples were submitted to several commercial laboratories for analysis of total cyanide. Results from the university studies and commercial laboratories were compared. Based on the study, an extraction method can be defined that will provide more accurate and reproducible results for total cyanide contained in solid samples. A high alkaline extraction is recommended when analyzing MGP samples for cyanide. When disposing of cyanide-containing wastes, maintaining the natural acidic pH will control leaching of cyanide.

21578 (PB–90-131616/XAB) **Rotation length and repeated harvesting influence Populus coppice production. Forest Service research note.** Strong, T. Forest Service, Rhinelander, WI (USA). North Central Forest Experiment Station. 1989. 6p. (FSRN-NC–350). Available from NTIS, PC A02/MF A01.

A coppice and a first-rotation stand of hybrid poplar barely differed in biomass yields beyond age 4. Repeated harvesting of coppice stands under short rotation reduced yields.

0909 Processing

Refer also to citation(s) 22616, 22712

21579 (BCR–4-03-842) **Chemicals and fermentable biomass via hydrotropic agent pretreatment.** B.C. Research, Vancouver, BC (Canada). Apr 1987. 52p. Contract EMR 02SQ.23216-4-6368. (MICROLOG–89-05631). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Hydrotropic pulping involves the removal of lignin from lignocellulosic materials by use of surface active agents. The method is attractive because the gentle solvating action of a hydrotropic agent does not involve the severe acid or alkaline reactions of conventional pulping processes. The process has been carried out on a poplarwood hybrid, Pupulus deltoides D38, to generate a pulp whose accessibility to the cellulase enzyme Maxazyme CL2000, as judged by D-glucose production, is ca 50%. This is greater than the 35% noted for Paprican's Hurricane Pulp prepared by comminution of poplarwood and comparable to the 45% observed for a steam exploded poplarwood produced by Stake Technologies.

However, when the yield of glucose which could be produced enzymatically is calculated more realistically on the basis of the wood feed and not upon the pulp product, the hydrotropic agent pretreatment process does not look so attractive. The reactions were conducted in a 33.3wt% sodium xylene sulphonate (SXS) solution at 140^{0}C for varying lengths of time up to 16 hours. The recovery of lignin solids containing SXS has been partly demonstrated and a possible use for this material as a phenol substitute in glue manufacture discussed. The hydrotropic pulping process has been shown to require the evaporation of large volumes of water for lignin recovery and liquor regeneration. The levels of capital investment required for reactors and vapour recompression evaporators make the process non- competitive with the Stake stem explosion process. 16 refs., 6 figs., 6 tbs.

21580 (CONF-890236–4) **Methanogenic gasification of wood.** Srivastava, V.J. (Institute of Gas Technology, Chicago, IL (USA)); Conrad, J.R.; Fannin, K.J.; Isaacson, H.R. Institute of Gas Technology, Chicago, IL (USA). 1989. 23p. Sponsored by Institute of Gas Technology. From 13. annual conference on energy from biomass and wastes; New Orleans, LA (USA); 13-17 Feb 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Anaerobic digestion of woody species is generally not considered technically feasible without some type of pretreatment for dissociation of biodegradable components, such as cellulose and hemicellulose, from a nonbiodegradable component, such as lignin. Work conducted at the Institute of Gas Technology (IGT) has demonstrated that significant conversion of different hardwood species for methane production can be accomplished without pretreatment other than particle size reduction and also without adding expensive nutrients. These studies utilized a novel wood inoculum developed at IGT using enrichment techniques. 25 refs., 7 figs., 8 tabs.

21581 (DOE/ER/13053–8) **Energetics of end product excretion in anaerboic bacteria and the metabolism of fatty acids by Syntrophomonas wolfei: Final report, March 15, 1985–March 14, 1989.** McInerney, M.J. Oklahoma Univ., Norman, OK (USA). Oct 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-83ER13053. Order Number DE90007549. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Anaerobic syntrophic bacteria degrade fatty acids which are important intermediates in anaerobic degradation and methanogenesis. These bacteria grow very slowly and require the presence of a hydrogen/formate-using organism to degrade fatty acids. Thus, these bacteria serve as models to study the biochemical aspects of mutualism and the energetics of slow growing organisms. We developed methods to physically separate cells of the anaerobic, fatty acid degrader, Syntrophomonas wolfei, from cells of the hydrogen user by Percoll gradient centrifugation and to selectively lyse S. wolfei cells using lysozyme. These methods allowed the study of the physiology of S. wolfei without significant contamination by cellular components of the hydrogen user. We also obtained pure cultures of S. wolfei by adapting the organism to grow on crotonate. Fatty acids were degraded by the β-oxidation pathway using a coenzyme A (CoA) transferase activity to activate the fatty acid and substrate-level phosphorylation reactions to synthesize adenosine-5′-triphosphate (ATP). The substrate specificity of the CoA transferase activity in the pure culture of S. wolfei differed from that found in the coculture suggesting that the ability to use crotonate resulted from an alteration of this enzyme. S. wolfei grown alone degraded crotonate in a manner similar to that of other crotonate-fermenting anaerobes, but the molar growth yields of S. wolfei were 2 to 3 times higher than those organisms. This suggests that the reduction of crotonyl-CoA to butyryl-CoA is energy yielding. S. wolfei contained a c-type cytochrome which may be involved in this reaction. S. wolfei synthesized large amounts of the storage polymer, poly-β-hydroxybutyrate (PHB). Radioisotopic incorporation experiments showed that PHB was synthesized directly from the β-oxidation intermediate rather than from the condensation of two acetyl-CoA molecules.

21582 (DOE/ER/13862–T1) **Genetics of bacteria that utilize one-carbon compounds: Annual report, January 1, 1988–October 15, 1989.** Hanson, R.S. Minnesota Univ., Navarre, MN (USA). Gray Freshwater Biological Inst. Nov 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13862. Order Number DE90008485. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Methylotrophic bacteria that grow on the one-carbon compounds; methane, methanol, methylamines and dichloromethane are a morphologically and physiologically diverse group of eubacteria. The 16S rRNA molecules of several gram-negative methylotrophs have been sequenced. Two phylogenetically related groups containing type I and type II methylotrophs have been identified. Each group contains two subgroups of bacteria. DNA probes homologous to 16S rRNA's of each group of methanotrophs have been synthesized and have been shown to hybridize only to the 16S rRNA's from target bacteria. We have mapped the positions of 15 genes controlling the synthesis of methanol dehydrogenase, cytochrome C_L and other functions required for the oxidation of methanol to formaldehyde in three species of type II methanotrophs. We have isolated a DNA-binding protein that binds to a cloned 172 bp sequence that is located upstream from the MDH structural gene. The function of this protein in the regulation of MDH synthesis will be investigated. The gene encoding the methane monooxygenase B component of *Methylosinus trichosporium* OB3b has been cloned and expressed in *Escherichia coli*. We intend to clone and map all five genes required for the expression of soluble MMO activity in *M. trichosporium* OB3b and to study the regulation of their synthesis. 5 refs.

21583 (LBH–89-05734) **Establishment of operating parameters for effective mechanical dewatering of wood residues.** Edwards, W.C.; Tam, P. Levelton (B.H.) and Associates Ltd., Vancouver, BC (Canada). Jun 1988. 143p. Contract EMR 51SZ.23216-6-6345. (MICROLOG–89-05734). Available from PC Energy, Mines and Resources Canada. Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study was undertaken to address the lack of fundamental understanding of dewatering of wood residues and the need for more information on the type and performance of equipment currently used. Data on the operation of dewatering presses was obtained from suppliers and equipment users. This information formed a basis for designing a test program and for assessing the results that were measured in the laboratory. Test were done at a laboratory scale to investigate three generic press configurations: platen press; ram press; and roller press. These designs are now used in one form or another in commercial dewatering presses. The laboratory results were correlated using a simple dewatering model, providing a valuable tool for predicting the effects of different operating conditions and material properties. The results of the test program, information obtained from users of dewatering presses and the fundamental understanding of dewatering obtained from a theoretical analysis were used to recommend means of improving existing presses and develop a new conceptual design. This design utilizes a low-pressure screw press and a high-pressure roll press. The screw press doubles as a feeder for the roll press and provides a uniform mat thickness. 13 refs, 52 figs., 12 tabs.

21584 (QU/CE–89-05746) **Process development of an integrated extractive fermentation system: Part of the Bioenergy Development Program (BDP).** Daugulis, A.J. Queen's Univ., Kingston, ON (Canada). Dept. of Chemical Engineering. 6 Nov 1987. 49p. Contract EMR 24ST.23216-6-6105. (MICROLOG–89-05746). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A novel process, extractive fermentation, has developed which overcomes the characteristic constraint of traditional means of ethanol production: end-product inhibition. In this process, the inhibitory ethanol product is selectively removed directly from the aqueous fermentation broth by an immiscible organic solvent, resulting in low ethanol concentrations in the aqueous phase, high reaction rates, significantly reduced water consumption, and the

prospect of recovering near-azeotropic ethanol from the extracting solvent. This report presents the results of a project aimed at scaling up and developing a laboratory-scale process development unit, and determining the cost of producing ethanol by an extractive fermentation system. The unit was based around a continuous flow, 7 l fermentation vessel, with a flash vaporization unit for ethanol recovery and solvent regeneration, and electronic process controls. The process was used to ferment glucose solution and was operated continuously over a 400 h period to demonstrate effective system performance. The extraction solvent used was ADOL® 85 NF, a commercially available bulk chemical composed largely of oleyl alcohol. The production of a concentrated (ca 80 wt %) ethanol stream by this process was successfully demonstrated. The solvent had excellent thermal and chemical stability and there was minimal solvent loss. Process improvements could, however, be made in the areas of solvent/broth disengagement, flash vaporization unit design, and process control. The cost analysis for a plant producing 20 million l/y of azeotropic ethanol indicated that the largest cost component was the price of the substrate and that a proper cost-optimization study is needed. 26 refs., 3 figs., 11 tabs.

21585 (TFRI–MR216e) **Charcoal production in Tanzania using improved traditional earth kilns.** Kimaryo, B.T. (Tanzania Forestry Research Inst., Timber Utilization Research Centre, Moshi, (Tanzania)); Ngereza, K.I. Tanzania Forestry Research Inst., Moshi (Tanzania). Timber Utilization Research Centre. Mar 1989. 29p. (MICROLOG–90-00253). Available from PC International Development Research Centre, 250 Albert Street, P.O. Box 8500, Ottawa, ON, CAN K1G 3H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A preliminary field survey of earth kilns was carried in nine villages in Tanzania. Only one design of the traditional earth kiln was found commonly adapted in the surveyed villages. The effect of the basic design on charcoal yield and production cost was evaluated for comparison among villages. The charcoal recovery percentages from single kiln-charges in the villages are unexpectedly quite high, ranging form 17 to 37%. The yield variations between villages are significant due to lack of field control of certain factors of production: tree species, wood density, billet moisture content, kiln capacity, operating skills and prevailing weather conditions. The unit production costs show no significant differences between village charges. Experimental charcoal burnings were then conducted to measure the technical and economical performances of five earth kiln designs. The recoveries between kiln designs range from 15 to 31%. The unit production costs also differ quite significantly between the kiln designs tested, ranging from 1 to 3 Tanzanian shillings per kg. The experimental results indicate that the Senegalese Casamance earth kiln is the most technically and economically efficient design, followed by the metal channel kiln, and improved version of the basic earth kiln. The adoption of either of these two designs by the rural charcoal producers may greatly improve the present traditional method of charcoal production in the country. 12 refs., 11 figs., 6 tabs.

21586 (WU/CE–90-00387) **Chemicals and fuels from biomass flash pyrolysis- part of the Bioenergy Development Program (BDP).** Scott, D.S. Waterloo Univ., ON (Canada). Dept. of Chemical Engineering. Feb 1988. 174p. Contract EMR 38ST 23216-6-6164. (MICROLOG–90-00387). Available from PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The work described in this report was undertaken to explore the possibilities of recovering specific components or fractions of the pyrolysis oils produced from wood by the Waterloo Fast Pyrolysis Process(WFPP). An extraction procedure using water as a solvent was developed to separate cabohydrate-derived water-soluble components from lignin-derived aromatic components. The pyrolytic lignin fraction obtained in this way was tested as a replacement for phenolformaldhyde resin in wood adhesive with encouraging results. The aqueous extract was used as a souce of hydroxyacetaldehyde or acetic and formic acids. Acetic and formic acids were readely recovered but the recovery of hydroxyacetaldehyde was difficult. A mild acid pretreatment of wood or commercial cellulose followed by pyrolysis after washing resulted in a pyrolysis liquid high in hydrolyzable sugars and low in acids or other carbonyl compounds. This result represents an alternative to enzymatic hydrolysis for the conversion of cellulose to fermentable sugars, inasmuch as sugar yields (as glucose equivalent) of 75% to 85% of the cellulose can be obtained with solution concentrations of 150 to 300 gm/litre. Preliminary tests wre carried out which showed that encouraging yields of C_3 to C_6 olefins could be produced directly be the WFPP. In summary, the Waterloo Fast Pyrolysis Process has demonstrated that a number of selective pyrolytic processes can be carried out by this process. This factor, coupled with great flexiliby in accepting a wide range of biomass feed-stocks, indicates a wide commercial potential for the WFPP. Preliminary results on pyrolysis catalysts for the fluidized-bed reactor and an account of the design of a mobile pyrolysis demonstration plant are given in an appendix.. 52 refs., 22 figs., 22 tabs.

0910 Properties and Composition

Refer also to citation(s) 21586

0920 Combustion

Refer also to citation(s) 21351

21587 (IRTA–90-00381) **How to use the CSA B415 performance standard to improve furnace efficiency.** LeMay, C. IRTA, Clarence Creek, ON (Canada). Jan 1987. 36p. Contract EMR 23216-6-6087. (MICROLOG–90-00381). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

To help the wood-burning appliance industry develop more efficient appliances, and to help the consumer to select the best appliance, the Canadian Standards Association has developed a methodology for rating the efficiency of, and the emissions from residential wood-burning appliances. This report documents the reliability of the dilution tunnel sampling procedure as a tool which can be used by Canadian manufacturers of wood heaters to develop cleaner-burning products. The first section describes the Canadian Standards Association B415 test methodology. The emphasis is placed on one part of this methodology, the dilution tunnel test, because it is more appropriate to manufacturers for in-house testing. The cost and materials required for this procedure are listed. The second section demonstrates how B415 can be used in wood stove development. A wood-burning appliance in the residential range was modified several times and, after each modification, was tested in order to determine the effect of that modification on performance. The addition of a catalytic block plus a brick liner reduced emissions by more than 50% and improved the thermal efficiency by 21% from the 65% level to the 79% level, with a consequent reduction in wood consumption. The major reduction in emissions means a cleaner and, therefore, safer chimney. 2 refs., 24 figs.

21588 (NBU/FE–46054) **Evaluation of and operating experience with a Heat Harvester green chip pre-furnance, 1985-1986.** Short, C.A. (Univ. of New Brunswick, Frederiction, NB (Canada)). New Brunswick Univ., Fredericton, NB (Canada). Dept. of Forest Engineering. 8 Jun 1987. 150p. Contract EMR 24ST.23216-4-6054. (MICROLOG–90-00383). Available from PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Tests were conducted on a fully automatic wood-chip-fuelled combustion system designated as model TB500H and manufactured by the Heat Harvester Corporation, Carrboro, North Carolina. The unit is rated at 90 to 180 kW (300,000 to 600,000 BTU/h) output, depending upon the fuel used, but was found to be limited to about 70 kW (250,000 BTU/h) gross energy input when fuelled with dry hardwood ships. Attempts to use the appliance for routing

heating in a house were not successful for many reasons. Automatic ignition did not occur reliably and ash removal did not take place as intended. Combustion chamber and fuel-feed components failed due to inability to endure the temperatures to which they were exposed and to failure to allow for thermal expansion in their design. Fuel feed from the system fuel hopper was unreliable and the handling system in the hopper required additions to overcome irregular fuel delivery rates due to funnel flow, piping and bridging in the fuel. Control system components failed and required expensive repairs, and the control system itself required modification in order to obtain proper operation. An automatically controlled, mechanical fuel handling system incorporating a flexible auger was arranged to move wood chips from a ground-level storage bin and into the combustion system fuel hopper. Because of the difficulties experienced with operation of the combustion system, the bin-to-hopper fuel handling system was not tested under routing, long-term, relatively unattended conditions; however, it appears to work as intended. 5 refs., 2 figs.

0930 Economic, Industrial, and Business Aspects

21589 (DOE/OR/21389–24) **Northeast Regional Biomass Energy Program: Progress report, October 1989 – December 1989.** O'Connell, R.A. CONEG Policy Research Center, Inc., Washington, DC (USA). Jan 1990. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG05-83OR21389. Order Number DE90007666. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The management structure and program objectives for the Northeast Regional Biomass Program remain unchanged from previous years. The funding for this year however has been considerably reduced permitting the issuance of grants to states to be held to $15,000/State. It also meant that fewer projects could be undertaken in the technical subcontract area. To alleviate this condition, a request was made to the Oak Ridge Operations Office to shift some formerly unobligated funds from the State Grant Program to the Technical Subcontract area. Approval was received to transfer $120, 000. Projects to be undertaken are currently in the selection process. Another action to be taken is to submit the "request for Grant" at an earlier date so that funds may be released on 1 July instead of 8 August as in previous years. In conjunction with this action, it is planned to issue state grants effective on 1 July. These actions are contingent upon DOE's release of FY90 funds to Oak Ridge Operations.

21590 (DU/IRES–89-05633) **Forests and fuelwood use in Nova Scotia: An overview and monitoring approach.** Gray, A. (Dalhousie Univ., Halifax, NS (Canada)); Cote, R. Dalhousie Univ., Halifax, NS (Canada). Inst. for Resource and Environmental Studies. 2 Feb 1988. 48p. (MICROLOG–89-05633). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Research has been conducted for several years in the areas of residential wood fuel use and forest management in Nova Scotia. This report presents an integrated overview of that research and develops recommendations and conclusions. The use of residential wood fuel has been increasing steadily since the late 1970's, for a variety of reasons, chiefly the rising price of home heating oil and electricity, coupled with government incentive programs to convert homes from oil heating. Surveys have shown distinct patterns of use that differ between urban, rural and small-town residents. The most significant aspects of these patterns are outlined, historical trends of usage are examined, and recommendations are made for improving the marketing and supply of fuel wood. The increased use of residential wood fuel, coupled with a growing interest in forestry waste biomass for heating, raises a number of questions regarding both the socio-economic dimension of forest management (e.g. the costs and benefits of wood fuel use; hardwood to softwood production conversion; structural barriers to increased use) and the environmental dimension (e.g. nutrient leaching due to whole tree harvesting; wildlife habitat loss). A related topic that is also considered is the potential for air pollution from wood burning devices. Nova Scotia residents, particularly in rural areas, have made a substantial committment to the burning of wood as a fuel. A central recommendation of the report is that a comprehensive and well-designed survey of residential wood fuel use in Nova Scotia is necessary, in order to provide accurate data over a long time period, for use in policy development and planning for residential wood fuel use in the province. 28 refs., 4 figs., 3 tabs.

21591 (RCA–BC-X-308) **Hog fuel availability in the north coastal and interior regions of British Columbia, 1986.** Appleby, P.W. (Reid, Collins and Associates Ltd., Vancouver, BC (Canada)). Reid, Collins and Associates Ltd., Vancouver, BC (USA). 1989. 54p. (MICROLOG–89-05344). Available from PC Petawawa National Forestry Institute, Distribution Centre, P.O. Box 2000, Chalk River, ON, CAN K0J 1J0; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

In 1986, a total of 6,500,000 bore-dry units (BDU) of hog fuel were produced, of which 2,500,000 BDU were utilized and 4,000,000 BDU were surplus. Two percent of the total hog fuel produced in 1986 was exported. Of the 2,500,000 BDU utilized, 84% was used for the production of steam, power, or heat, 12% was used for pulp furnish, 2% was used for particleboard production, and 2% was used for a diversity of local uses within the north coastal and interior regions of British Columbia. Sawmills were the major producers of hog fuel (90%). Pulpmills were the major consumers (60%), followed by sawmills (30%). The major portion of the net available hog fuel surplus (94%) is located at sawmills. The Prince George East sub-region is the largest producer and user of hog fuel. It also has the largest net available supply of surplus hog fuel. In 1986, virtually all of the surplus (98%) was disposed of by incineration. Twenty-three percent of the hog fuel produced, or almost 1,500,000 BDU, was transferred between one mill location and another. Of this, 71% was transferred between mills in the same sub-region and 29% between mills in different sub-regions. The net available surplus hog fuel could vary appreciably from year to year, depending on the relative operating levels of the wood product and pulp sectors of the forest industry. Hog fuel production and utilization in 1986 were both significantly higher than was the case in 1976, when a previous study was undertaken. However, the net available surplus was close to 4,000,000 BDU in both years. It is expected that gradual decreases in total hog fuel production and gradual increases in total hog fuel utilization will result in a gradual decrease in surpluses under average mill operating levels. 1 fig., 34 tabs.

0950 Environmental Aspects

Refer also to citation(s) 21575

21592 (EC–90-00642) **A test burn of chlorophenol contiminated wood wastes at Northwood pulp mill, Prince George, B.C. [British Columbia]: Summary report.** Environment Canada, Ottawa, ON (Canada); British Columbia Ministry of Environment and Parks, Victoria, BC (Canada). Jul 1989. 57p. (MICROLOG–90-00642). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Environment Canada and the B.C. Ministry of Environment conducted a series of tests on an industrial woodwaste (hog fuel) fired boiler at Northwood Pulp and Timber Ltd., Prince George, B.C. The test burn was designed to determine the capability of this combustion system to destroy low levels of chlorophenols, dioxins and furans that sometimes contaminate hog fuel. The test burns, completed in September 1987, involved the burning of hog fuel specially acquired without adding chlorophenol solution; hog fuel with chlorophenol solution added at a nominal concentration of 50 ug/g; and hog fuel with chlorophenol solution at a nominal concentration of 400 ug/g. Ambient air quality was monitored concurrently during the days of testing. During all test conditions, the boiler was maintained at constant steam production of about 100 tonnes/hr, or about 60% of maximum continuous rating. The lowest destruction

efficiency of dioxins and furans was 99.9993% and for chlorophenols, 99.9917% when chlorophenol solutions were added. These destruction efficiencies occurred at an estimated minimum furnace temperature of about 920C and combustion gas residence time of approximately 3 seconds. Dioxins and furans in ambient air were non-detectable during all test conditions. 12 refs., 6 figs., 6 tabs.,

21593 (OE/ARB–90-01077) **Ambient air quality post-operational survey Part 1: Energy-from-waste plant, Victoria Hospital Corporation, London, Ontario.** Chapman, R. Ontario Ministry of the Environment, Toronto, ON (Canada). Air Resources Branch. Jan 1989. 106p. (MICROLOG–90-01077). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A mobile air monitoring unit measured ambient air quality parameters near the Victoria Hospital Corp. Energy-From-Waste (EFW) plant in London, Ontario, during late June 1988. This was the first part of the post-operational survey to determine the ambient air concentrations of a large number of compounds which could be emitted from the plant in various concentrations. The plant was operated at 80%-100% of capacity during the survey. The effect of the EFW incinerator emissions on the ambient air quality during this survey was not significant or noticeable, based on several factors. The 1-hour average ambient air concentrations of the common contaminants such as CO and NO were very similar to the pre-operational survey results. The wind and pollution rose plots for CO, NO and total hydrocarbons did not point to the EFW stack as a source of these emissions during the survey period. The ambient air concentrations of 132 organic compounds as determined by gas chromatography showed that none of the air quality criteria was exceeded or approached, and generally agreed with the results of the 2 pre-operational surveys. There was no visible plume and no odours were perceived at any time by the monitoring crew. 2 figs., 5 tabs.

0970 Legislation and Regulations

Refer also to citation(s) 21894

0980 Waste Management

Refer also to citation(s) 21575

0990 Products and By-Products

Refer also to citation(s) 21576, 21581

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 21146

21594 (OU/C–89-06234) **Mechanisms for the homogeneous, thermal conversion for methane to ethane and other saturated hydrocarbons: Volumes 1 and 2.** Bossard, A.R. Back, M.H. (Univ. of Ottawa, ON (Canada)). Ottawa Univ., ON (Canada). Dept. of Chemistry. [1989]. 104p. Contract EMR 23440-7-9239/01-SS. (MICROLOG–89-06234). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The objective of this study is the investigation of a method for the thermal homogenous conversion of methane into ethane and other higher hydrocarbons. The four major products, methane, ethane, propylene, and l-butene, constitute about 80% of the products that are volatile at room temperature. In the first part of this study, the kinetics of the formation of these products in the mixtures of ethylene and methane were investigated. The main problem was to find conditions of temperature, pressure, and composition of the mixture where the conversion of methane and ethane was at a maximum. The experiments were performed over the temperature range 500-580^{0}C, at partial pressures of ethylene from 12.5 to 200+ atmospheres and at ratios of methane over ethylene of 0 to 8. The results show that homogenous, thermal gas phase radical reactions can lead to a significant conversion of methane into higher hydrocarbons. As well, the selectivity of the products, particularly the yields of ethane and propylene, may be altered by the choice of reaction conditions or additive. In the second part of the study, the apparatus, gases, and experimental procedure were identical, but the sampling technique was improved. Twenty series of experiments were done at the temperatures of 650, 700, and 750^{0}C. At these temperatures, initial rates of product formation were too fast to measure. At temperatures in the region of 725 ^{0}C, ethylene is an efficient sensitizer of the conversion of methane to propylene, the main advantage of the use of hydrocarbon sensitizer is that no carbon is lost as carbon oxides. 59 refs., 19 figs., 46 tabs.

1004 Combustion

Refer also to citation(s) 21351

1005 Transport, Handling, and Storage

Refer also to citation(s) 21595

1008 Waste Management

Refer also to citation(s) 21139

1009 Environmental Aspects

21595 (CONF-881205–6) **Biodegradation of old town gas site wastes.** Srivastava, V.J. (Institute of Gas Technology, Chicago, IL (USA)); Kilbane, J.J.; Kelley, R.L.; Akin, C.; Hayes, T.D.; Linz, D.G. Institute of Gas Technology, Chicago, IL (USA); Gas Research Inst., Chicago, IL (USA). [1988]. 29p. Sponsored by Institute of Gas Technology. From Symposium on coal, oil, and gas biotechnology; New Orleans, LA (USA); 5-7 Dec 1988. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The Institute of Gas Technology (IGT) has been developing several techniques to improve biodegradation rates over and above what can be achieved by simply adding nutrients and water and adjusting soil pH: chemical and biological treatments to increase the bioavailability of PAH's to microorganisms for catabolism; the addition of growth substrates to promote cometabolism of multi-ring PAH's that cannot be degraded otherwise; and the addition of a specially developed, mixed bacterial culture to ensure the presence of required types and quantities of PAH-degrading microorganisms. Further work is needed, however, to optimize the soil treatment protocols and to determine the effects of other organic components and heavy metals present in the soil and environmental factors on the overall treatability of the contaminated soil. 6 refs., 12 figs., 5 tabs.

21596 (PB–90-132010/XAB) **Soil-gas investigations at MGP (manufactured gas plant) sites: An evaluation of alternative compounds. Topical report, January 1989-June 1989. Final report.** Roberson, C.; Cutler, J.L. Atlantic Environmental Services, Inc., Colchester, CT (USA). Jun 1989. 59p. Available from NTIS, PC A04/MF A01.

Soil-gas surveys are frequently used to detect hotspots of contamination during the initial phases of investigation at manufactured gas plant (MGP) sites. Most soil-gas surveys at MGP sites have used benzene, toluene, and xylene (BTX) as target analytes. The technique, however, has failed to detect coal tar contamination in some instances. Consequently, the objective of this research was to evaluate the use of alternative target analytes, including carbon disulfide, thiophene, pyridine, ethylbenzene, styrene and 1,2,4-trimethybenzene for the detection of tars at MGP sites. Of these, only ethylbenzene and 1,2,4-trimethylbenzene were consistently detected in tars.

21597 (PB–90-132028/XAB) **Manufactured gas plants and the National Priorities List: A technical review. Topical report, August 1988-July 1989. Final report.** Wargo, L.E.; Unites, D.F.; Menzie, C. Atlantic Environmental Services, Inc., Colchester, CT (USA). Jul 1989. 63p. Available from NTIS, PC A04/MF A01.

The United States Environmental Protection Agency estimates that there are between 1,000 and 1,500 manufactured gas plant (MGP) sites in the United States. Many of these sites are listed in the Comprehensive Environmental Compensation and Liability Act Information System (CERCLIS), and eight sites are listed on or proposed for the National Priorities List (NPL). Seven of the eight MGP sites that are listed or proposed for the NPL are contaminated with tar associated with the manufacture of coal gas. A research project under the Gas Research Institute program for the management of MGP sites seeks to determine why these seven MGP sites were proposed for the NPL. The study explores factors that triggered the discovery of each site and identifies those factors that confirm the sites as NPL candidates. The objective of the study is to assist in defining key risk issues and technology options at MGP sites and developing site-management strategies.

13 HYDRO ENERGY

1301 Resources and Availability

Refer also to citation(s) 22589

1302 Site Geology and Meteorology

21598 (OH/RD–89-134-K) **Ear Falls GS [generating station]: Foundation investigation.** Ontario Hydro Research Div., Toronto, ON (Canada). 7 Jul 1989. 30p. (MICROLOG–89-06330). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

An investigation of the bedrock foundation at Ear Falls Generating Station was undertaken. This program involved the drilling of boreholes through the power-house concrete floor and the underlying rock bed, logging the core, examining the boreholes with a borehole camera, and measuring water levels. It was found that the rock foundation was performing adequately; also, there was no viable indication of slippage or settlement between the concrete structure and the rock foundation. However, based on the assumption that the plant will be in operation for at least 30 years, the long-term integrity of the rock mass immediately below the concrete/rock interfaced is of some concern. The following recommendations are provided to address this concern: the flow velocities should be measured in boreholes at selected locations; a visual inspection of the rock mass should be undertaken at the time of the flow measurements, the sample taken from borehole 1 should be analyzed in greater detail, so as to attempt to determine its origin; finally, air drills should not be used inside manned stations, because of their noise.

1303 Plant Design and Operation

21599 (AIL–90-00382) **Syphon hydro research and development, 1984-1989.** FitzPatrick, J.B. Acres Consulting Services Ltd., Niagara Falls, ON (Canada). May 1989. 17p. (MICROLOG–90-00382). Available from PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The elimination of intake gates for dewatering the units for inspection, coupled with minimal impact on the existing forebay structures of dams, makes syphon hydro an attractive option for small power generation. Acres International Limited has participated in 6 syphon hydro studies in the USA and Canada. One of the overall goals of these studies was to achieve a generic design of installations which would be an ideal alternative to using hydrocarbon-fueled power systems in small communities. Syphon hydro installations can be fully automated and operated unattended. A literature review on the subject included the analysis of site characteristics and several relevant laboratory studies to summarize performance information relative to intake geometry, submergence, transients and air entrainment. To supplement that information, a laboratory study was carried out at model length scales of 1/2 and 1/3, with model discharges and bead corresponding to typical micro hydro sites. A testing program was implemented to examine 2 basic intake configurations, the circular and rectangular bellmouths, and to assess quantitatively their response to a range of submergences by monitoring the power output. Observations at the crown of the syphon, constructed of clear acrylic plastic, gave an insight to the behavior of air in the installation. Another series of tests was run to examine the submergence for a syphon intake on a sloping face. In a further study, carried out in 1986, the performance of several vortex suppression devices was tested on a 1/5 scale model while varying the conditions of the test. The analysis of the data indicated a potential region of acceptable vortex behavior as a function of the intake submergence and the approach channel Froude number. Future research work is outlined. 5 refs., 24 figs., 1 tab.

21600 (OU/CVE–89-05945) **Design of low-cost flowthrough rockfill dams and spillways.** Garga, V.K. (Univ. of Ottawa, Ottawa, ON (Canada)); Townsend, R.D.; Hansen, D. Ottawa Univ., ON (Canada). Dept. of Civil Engineering. 9 Sep 1987. 82p. Contract EMR 24ST.23216-6-6298. (MICROLOG–89-05945). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A literature review was performed on the present knowledge of non-Darcy flow through porous media, of seepage through rockfill, and of the hydraulic design of flowthrough rockfill dams. The literature review showed that power-type expressions for non-Darcy flow through porous media vary greatly as to values of the empirical coefficient in these expressions. It also showed that the traditional design methods for rockfill dams of the type considered in this report are divided into overflow design and flowthrough design. A preliminary parametric study was performed of the flowthrough characteristics of rockfill placed in a test cylinder 1 m long and 28.5 cm in diameter. The influence of such factors as rock size, shape, gradation, degree of compaction, and angularity were investigated. It was found that, for crushed limestone, the coefficient in a power-type expression for non-Darcy flow can be estimated if the mean hydraulic radius is known. It is therefore possible that a governing equation for non-Darcy flow could be obtained without performing expensive hydraulic experiments. Preliminary tests in a flume 13 m long and 38 cm wide were performed to study the hydraulic behavior of model flowthrough rockfill dams. It was found that a model dam having an impervious element (cut-off wall) extending only part-way to the crest did not demonstrate greater hydraulic stability than a model dam having a cut-off wall extending the full height of the model dam. Use of partial cut-off walls, which do not maximise the available head for a given volume of fill, do not therefore represent the most economical design. The flume studies also indicated that it may be desirable to unify the concepts of overflow and flowthrough in rockfill dams for the hydraulic design of such structures. 45 refs., 23 figs., 5 tabs.

1306 Environmental Aspects

21601 (ANA–89-15) **Evolution of limnological conditions in lakes of the Nelson and Rat-Burntwood river systems after Churchill River diversion and Lake Winnipeg regulation: 1. An overview.** Ramsey, D.J.; Livingston, L.; Hagenson, I. Agassis North Associates, Winnipeg, MB (Canada); Manitoba Dept. of Natural Resources, Winnipeg, MB (Canada). Fisheries Branch. Mar 1989. 102p. (MICROLOG–89-05889). Available from PC Manitoba Legislative Library, 200 Vaughan St., Winnipeg, MB, CAN R3C 1T5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Studies were initiated of the limnology of Rat and Threepoint lakes on the Churchill River diversion and of Cross, Sipiwesk, Split, and Stephens lake on the Nelson River in 1985. The hydrologic regimes of these lakes have been altered by Lake Winnipeg regulation or Churchill River diversion or by both developments. This report summarizes the water quality data collected through 1987 and the phytoplankton and zooplankton data collected through 1988. These data are compared to pre-development data reported by the Lake Winnipeg, Churchill, and Nelson Rivers Study Board to provide an overview of the changes in water quality and n the phytoplankton and zooplankton communities which have of changes in analytical methodology which may confound the interpretation also are considered. Limitations of the report conclusions are identified and types of new or existing data collection and analysis which could minimize or eliminate these restrictions are suggested. 8 refs., 34 figs., 18 tabs.

21602 (DOE/BP–1327) **Draft global warming study: Draft 1990 Resource Program.** USDOE Bonneville Power Administration, Portland, OR (USA). Jan 1990. 35p. Sponsored by U.S. DOE Management & Administration. NONE - BPA. Order Number DE90008446. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The 1990 Resource Program Global Warming Study examines potential Bonneville Power Administration (BPA) resource alternatives related to the risk of global warming. The study evaluates strategies for reducing net carbon emissions, and identifies the net carbon contribution of certain resource strategies designed to reduce those emissions. Carbon dioxide (CO_2) is the "greenhouse gas" most associated with electricity production. The main purpose of the global warming study is to identify possible courses of action that BPA might take to reduce its contributions to the risk of global warming and to estimate the efficacy and costs of each approach. The principal measure of effectiveness is the reduction in total atmospheric carbon emissions compared to a base case. 13 refs., 2 tabs.

21603 (DOE/BP/01830–4) **Velocity measurements at six fish screening facilities in the Yakima River Basin: Annual report, 1988.** Abernethy, C.S.; Neitzel, D.A.; Lusty, E.W. USDOE Bonneville Power Administration, Yakima, WA (USA); Pacific Northwest Lab., Richland, WA (USA). Nov 1989. 190p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90008448. Available from NTIS, PC A09/MF A01 - OSTI.

The Bonneville Power Administration (BPA), the United States Bureau of Reclamation (USSR), and the Washington State Department of Ecology (WDOE) are funding the construction and evaluation of fish passage facilities and fish protection facilities at irrigation and hydroelectric diversions in the Yakima River Basin, Washington State. The program provides offsite enhancement to compensate for fish and wildlife losses caused by hydroelectric development throughout the Columbia River Basin, and addresses natural propagation of salmon to help mitigate the impact of irrigation in the Yakima River Basin. This report evaluates the flow characteristics of the screening facilities. Studies consisted of velocity measurements taken in front of the rotary drum screens and within the fish bypass systems during peak flows. Measurements of approach velocity and sweep velocity were emphasized in these studies; however, vertical velocity was also measured. 5 refs., 18 figs., 15 tabs.

21604 (DOE/BP/14903–2) **Protection of wild adult steelhead in Idaho by adipose fin removal: Five year completion report: Final report.** Duke, R.C. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Idaho Dept. of Fish and Game, Lewiston, ID (USA). Apr 1989. 44p. Sponsored by U.S. DOE Management & Administration. DOE Contract AI79-84BP14903. Order Number DE90008449. Available from NTIS, PC A03/MF A01 - OSTI.

Steelhead trout reared in Idaho hatcheries for release during the 1984–1988 outmigrations were adipose fin clipped to differentiate between wild/natural and hatchery-reared fish. From 1984–1988, 34 million hatchery-reared steelhead trout were clipped and 30.1 million were released; the difference being made up by hatchery mortality and the percent of acceptable clips. Since 1987, the adipose clip has given protection to all wild/natural steelhead and identified them from hatchery stocks. 135 refs.

21605 (DOE/BP/39461–5) **Yakima River spring chinook enhancement study: Annual report FY 1988.** Fast, D.E. (Yakima Indian Nation, WA (USA). Fisheries Resource Management); Hubble, J.D.; Kohn, M.S. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Yakima Indian Nation, WA (USA). Fisheries Resource Management. Jan 1990. 101p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract BI79-83BP39461. Order Number DE90008452. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Smolt outmigration was monitored at Wapatox on the Naches River and Prosser on the lower Yakima. The spring outmigration at Wapatox was estimated to be smolts. The survival from egg to smolt was calculated using the 1986 redd counts and the 1988 smolt outmigration at Prosser. The smolt to adult survival was calculated based on the 1983 smolt outmigration estimated at Prosser and the 1984 return of jacks (3 year old fish), the 1985 return of four year old adults, and the 1986 return of five year old fish to the Yakima River. 13 refs., 4 figs., 47 tabs.

21606 (DOE/DP–1302) **Draft 1990 Resource Program.** Bonneville Power Administration, Portland, OR (USA). Dec 1989. 801p. Sponsored by U.S. DOE Management & Administration. NONE - BPA. Order Number DE90008447. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Draft 1990 Resource Program describes the actions Bonneville Power Administration (BPA) proposes to take to develop new resources to meet the power requirements of its customers. The main focus is to determine what BPA should do in FY's 1992 and 1993, and the draft proposes Energy Resource budgets for these years. The Draft 1990 Resource Program addresses and makes recommendations on some resource-related policy issues. This document is a summary providing an overview of the analysis, thought process, and recommendations of the Resource Program. This Resource Program is a proposal and the conclusions reached here are preliminary. 2 figs., 5 tabs.

21607 (EPRI-GS–6712) **Fish protection systems for hydro plants: Test results.** Electric Power Research Inst., Palo Alto, CA (USA); Stone and Webster Engineering Corp., Boston, MA (USA). c Feb 1990. 368p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Electric Power Research Institute (EPRI) sponsored field and laboratory studies of strobe lights, mercury lights and hammers (sound generators) to determine their ability to attract and repel fish. Laboratory studies were intended to provide information on the basic behavioral response of a variety of fish species to these devices. In the field, the devices were installed at five sites where improved fish passage around hydraulic turbines would be desirable. Results of testing, as presented in this interim report, demonstrated that some fish species were definitely attracted or repelled by the test devices, other species showed no reaction at all, while still others displayed equivocal responses. Results with species in the third category are being investigated further. 107 figs., 69 tabs.

1307 Power-Conversion Systems

21608 (CSR–C225F) **Hydraulic testing of multiple siphon generator intakes.** Canadian Seabed Research Ltd., Halifax, NS (Canada). Jun 1988. 71p. Contract EMR 23283-7-6100/01-SZ. (MICROLOG–89-05650). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Physical model studies were undertaken at 1:15 scale to investigate hydraulic features of locating intakes to several modular siphon generator units in close proximity to one another. The project was to simplify preparation and increase the reliability designs and cost estimates for low head power developments which

used pre-engineered and commerically available siphon units. Experiments were performed to determine the range of conditions over which the intakes could be operated without undue vortex formation. Effectiveness of basic vortex prevention techniques were examined. Tests were carried out to gauge the effects of angle of approach, discharge, submergence, bottom clearance and approach velocity on hydrostatic and differential horizontal and vertical pressure imbalances across the intake. It was concluded that the greatest feasible number of banked siphon modules would benefit the performance of the system as a whole as the least favorable operating conditions generally occured at the upstream intakes and at high siphon discharges. An approach channel forming 120 degrees angle with the intake panel proved to be the overall optimum configuration of the three approach directions tested. Improvements to intake flow conditions could be achieved by minimizing corner effects, increasing submergence depth and locating the bottom of the intakes as close to the approach channel floor as was feasible with respect to sedimentation or other concerns. The most adverse operating conditions occured for a 180 degrees high velocity approach channel flow bypassing the intake panel which produced a strong recirculation inside the siphon modules. 3 refs., 18 figs., 2 tabs.

14 SOLAR ENERGY

21609 (ORF–ES/EDP-87-02) **Study of harmonic reduction alternatives for the NSTF [National Solar Test Facility] solar simulation: Final report.** Bruyn, P.A. (Ontario Research, Mississauga, ON (Canada)). Ontario Research Foundation, Sheridan Park, ON (Canada). 22 Jan 1987. 272p. Contract EMR 23216-6-6616. (MICROLOG–89-05613). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A 120 kW dc arc lamp, designed and built by Vortek Industries is being used as a solar simulator at the National Solar Test Facility (NSFT) operated by Ontario Research Foundation for Energy, Mines and Resources Canada. The ripple in the irradiance of the arc lamp, was examined to determine its magnitude and recommend a cost effective solution to reduce it to an acceptable level. The 120 kW arc lamp's power supply is a six pulse ac-to-dc converter. The percentage of ripple in the light intensity, which is identical to the ripple in the arc's current, ranged from 90% at the minimum light intensity to 15% at the maximum light intensity. Various methods, ranging from alternate high current dc sources to different harmonic filtering schemes, were studied. A high frequency switching power supply was identified as the best way to reduce the ripple, and the fluctuations caused by the arc's inherent instabilities, to below 1%. This can only be achieved by a low ripple power supply design (i.e.<0.5%) with a fast response time constant, that will control the magnitude of the light intensity fluctuations in the arc by means of a feedback loop. 6 refs., 190 figs., 15 tabs.

1401 Resources and Availability

Refer also to citation(s) 22464

21610 (DOE/CH/10093–60) **Solar thermal program summary, fiscal year 1989: Volume 1, Overview.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009475. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The nation faces many difficult challenges in energy supply and use. These challenges involve numerous national issues, including energy security, energy cost, international balance-of-trade, and international competitiveness. Energy use directly affects environmental quality as well. Growing, pervasive problems with atmospheric pollution, water resources, acid rain, and the greenhouse effect may ultimately limit the burning of fossil fuels. We need to find ways to ameliorate these environmental problems while maintaining assured access to the energy resources our nation requires. Concentrated sunlight is a versatile and high-quality form of energy that can help us meet our energy needs. Solar thermal energy systems concentrate the sun's radiation to generate electricity, produce high-temperature heat for industrial and commercial uses, and carry out various chemical reactions that take advantage of the unique attributes of highly concentrated sunlight. Solar thermal technology has many applications, including electrical power generation, hazardous waste destruction, and other advanced applications such as materials processing and the pumping of lasers using very high concentration. Solar thermal technology is a desirable energy supply option for several reasons. Not only is it a strategically secure energy source, but its impact on the environment is minimal. The construction of solar thermal systems has certain advantages too: plants can be built quickly and in modular units to respond to immediate needs as well as to future growth. More than 200 MW of electricity, enough to supply 60,000 homes with their regular supply of electricity, is being produced today with this technology. 24 figs.

21611 (SERI/TR–215-3513A) **Spectral solar radiation data base documentation: Volume 1.** Riordan, G.J.; Myers, D.R.; Hulstrom, R.L. Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 62p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009447. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Solar Energy Research Institute (SERI), Electric Power Research Institute, Florida Solar Energy Center, and Pacific Gas and Electric Company cooperated to produce a spectral solar radiation data base representing a range of atmospheric conditions. These data will help to characterize the natural variability in the spectral (color) content of outdoor solar radiation so that the sensitivity of spectrally selective solar devices (such as photovoltaics) to these variations can be studied quantitatively. Volume I of this report documents the history, approach, content and format of the data base; Volume II contains graphs and field notes for each of the spectral data sets. The data reside on magnetic tape at SERI. 18 refs., 29 figs., 5 tabs.

1403 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21610, 21614, 21625

1405 Solar Energy Conversion

Refer also to citation(s) 21627, 22328, 22755

21612 (AIST–8903-1) **Japan's Sunshine Project. 1988 Annual summary of solar energy R and D program.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 504p. (In Japanese). Order Number DE90753039. Available from NTIS (US Sales Only), PC A22/MF A01.

An outline of 1988 annual summary of solar energy R and D program was described. In fundamental research on new solar cells, advanced technology of heterojunction formation is developed to improve the performance of crystalline silicon thin film. On the researchs of amorphous solar cells, studies of local structure in amorphous silicon, electronic states, defect states, interface of amorphous silicon, and mechanism of photo-CVD and quality of the films, were conducted. Furthermore, materials for amorphous solar cell, solar cell physics and structure, and reliability physics were studied. As for the technical development for the practical use of photovoltaic power generation system, the followings were investigated; the production of high purity silica and silicon from low grade silica sand, production of silicon sheets by new casting technique and spinning method, and realization of high efficiency polycrystalline solar cell. On the amorphous solar cell, low-cost practical application through fabrication of high quality and large area amorphous cells, was studied. Evaluation systems for photovoltaic cells and support technology for photovoltaic power generation such as power inverter, electric storage device, have been developing. As for the utilization system of photovoltaic power, stand-alone dispersed system was investigated. On the utilization of solar thermal

energy, cooling/heating and hot-water supply systems were investigated, furthermore, R and D of solar thermal energy application for industrial processes were conducted. 3 refs., 229 figs., 45 tabs.

21613 (AIST–8903-2) **Japan's Sunshine Project. 1988 Annual summary of solar energy R and D program.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 486p. Order Number DE90753040. Available from NTIS (US Sales Only), PC A21/MF A01.

An outline of 1988 annual summary of solar energy R and D program was described. In fundamental research on new solar cells, advanced technology of heterojunction formation is developed to improve the performance of crystalline silicon thin film. On the researchs of amorphous solar cells, studies of local structure in amorphous silicon, electronic states, defect states, interface of amorphous silicon, and mechanism of photo-CVD and quality of the films, were conducted. Furthermore, materials for amorphous solar cell, solar cell physics and structure, and reliability physics were studied. As for the technical development for the practical use of photovoltaic power generation system, the followings were investigated; the production of high purity silica and silicon from low grade silica sand, production of silicon sheets by new casting technique and spinning method, and realization of high efficiency polycrystalline solar cell. On the amorphous solar cell, low-cost practical application through fabrication of high quality and large area amorphous cells, was studied. Evaluation systems for photovoltaic cells and support technology for photovoltaic power generation such as power inverter, electric storage device, have been developing. As for the utilization system of photovoltaic power, stand-alone dispersed system was investigated. On the utilization of solar thermal energy, cooling/heating and hot-water supply systems were investigated, furthermore, R and D of solar thermal energy application for industrial processes were conducted. 214 figs., 41 tabs.

21614 (DOE/CH/10093–58) **Photovoltaic energy program summary: Volume 1, Overview, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009473. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1989, the US photovoltaic industry enjoyed a growth rate of 30% in sales for the second year in a row. This sends a message that the way we think about electricity is changing. Instead of big energy projects that perpetuate environmental and economic damage, there is a growing trend toward small renewable technologies that are well matched to end-user needs and operating conditions. As demand grows and markets expand, investment capital will be drawn to the industry and new growth trends will emerge. The photovoltaic industry around the world achieved record shipments also. Worldwide shipments of photovoltaic (PV) modules for 1989 totaled more than 40 megawatts (MW), nearly a 20% increase over last year's shipments. The previous two years showed increases in worldwide shipments of 23% and 25%, respectively. If this growth rate continues through the 1990s, as industry back orders would indicate, 300 to 1000 MW of PV-supplied power could be on line by 2000. Photovoltaic systems have low environmental impact and they are inexpensive to operate and maintain. Using solid-state technology, PV systems directly convert sunlight to electricity without high-temperature fluids or moving parts that could cause mechanical failure. This makes the technology very reliable. Thousands of people around the world have lights, water, and refrigerated medicines because of electricity provided by small- scale applications of photovoltaics. Now, photovoltaic technology is ready for incorporation into our utility power mix. Not only the United States, but Japan, Germany, Italy, and several other foreign countries are positioning themselves to capture a large share of the future multibillion dollar market from photovoltaics–profits are already visible. The race is on to see who will gather the lion's share of the economic and environmental benefits to be derived from the clean, high-technology photovoltaic market. 25 figs.

21615 (DOE/ET/20279–1) **Residential solar photovoltaic systems: Final report, July 1982–June 1986.** Kern, E.C. Jr. Massachusetts Inst. of Tech., Cambridge, MA (USA). Jun 1986. 86p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76ET20279. Order Number DE90008432. Available from NTIS, PC A05/MF A01 - OSTI.

In 1979, Massachusetts Institute of Technology prepared a Department of Energy plan for the development of roof-mounted, grid-connected photovoltaic systems for residential applications. Ambitious in concert with the National Photovoltaic Program Plan, the "Residential Plan" assumed that the DOE goal of $0.50 per peak watt photovoltaic modules would be met in 1986. The national commitment to develop renewable energy sources, high at outset of the plan's implementation, has since diffused. Consequently, the success of the DOE "Residential Project" in meeting its goals to develop distributed grid-connected photovoltaic systems has not been widely recognised. Current DOE program efforts are aimed at identifying and developing photovoltaic materials with lower manufacturing costs and higher power generation efficiency. Three years ago, in July 1982, the DOE Residential Project management was restructured. The project was started by MIT Lincoln Laboratory and the project's major experimental facilities (Residential Experiment Stations) were originally directed by Lincoln Laboratory and funded through Laboratory subcontracts. Since mid-1982 the project has been directed by Sandia Laboratories, with MIT solely responsible for the Northeast Residential Experiment Station. 11 refs., 28 figs., 17 tabs.

21616 (DOE/ET/20279–T15) **Photovoltaic systems for export application.** Duffy, J.; Campbell, H.; Sajo, A.; Sanz, E. Lowell Univ., MA (USA). 30 Jun 1988. 87p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76ET20279. Order Number DE90008431. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

One approach to improving the competitiveness of photovoltaic systems is the development of designs specifically for export applications. In other words, where is it appropriate in a system design to incorporate components manufactured and/or assembled in the receiving country in order to improve the balance of payments for that country and to increase photovoltaic exports from the US? What appears to be needed is a systematic method of evaluating the potential for export from the US of PV systems for various applications in different countries. Development of such a method was the goal of this project. This report summarizes the work on the project. In particular, this overview section includes a brief summary of the methodology and findings of the project. The project was divided into four tasks: (1) review current system export practice; (2) select promising export regions; (3) survey resources and markets in a designated country; and (4) develop a system design criteria and method. The following chapters of the report contain more detailed information on these tasks. 62 refs., 2 figs., 8 tabs.

21617 (N–90-13886) **The photovoltaic properties of an Al In As/InP heterojunctions grown by LPE method. Final technical report.** Wang, E.Y. Arizona State Univ., Tempe, AZ (USA). Oct 1989. 18p. (NASA-CR–185996;NAS–1.26:185996). Available from NTIS, PC A03/MF A01.

Work is presented on heterojunction solar cells which were studied under the NASA/Arizona State University intern program. The heterojunction solar cells were fabricated by the liquid phase epitaxy method. The basic conversion efficiency was measured at 5 percent. It was determined that a thicker epilayer is needed, and that the density of recombination center should be reduced to give a smaller saturation current and hence a larger open-circuit voltage.

21618 (N–90-14672) **Results of the 1989 NASA/JPL balloon flight solar cell calibration program.** Anspaugh, B.E.; Weiss, R.S. Jet Propulsion Lab., Pasadena, CA (USA). Nov 1989. 40p. (NASA-CR–186114;JPL-PUBL–89-47;NAS–1.26:186114). Available from NTIS, PC A03/MF A01.

The 1989 solar cell calibration balloon flight was successfully completed on August 9, 1989, meeting all objectives of the program. Forty-two modules were carried to an altitude of 118,000 ft (36.0 km). The calibrated cells can now be used as reference standards in simulator testing of cells and arrays.

21619 (NMRDI–2-77-5609) **Design optimization of short focal length photovoltaic modules: Final technical report.** Erbert, V.; Doherty, J.E.; Corio, R.P. Wattsun Corp., Albuquerque, NM

(USA). Jan 1990. 77p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90007783. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The first tasks completed were design optimization of submodule components resulting in selection of a final module design for production. Performance testing was conducted by Sandia National Laboratories and analysis of automated manufacturing techniques was begun. A cost analysis, following the Department of Energy's guidelines, was completed along with the successful development and testing of a low cost prototype tracking system. 5 refs., 20 figs., 23 tabs.

21620 (SAND–89-2236C) **Developments in solar photocatalysis for destruction of organics in water.** Pacheco, J.E. (Sandia National Labs., Albuquerque, NM (USA)); Carwile, C.; Magrini, K.A.; Mehos, M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900210–23: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007685. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are developing a process that has the potential to destroy a wide range of organic contaminants in water using solar energy and a titanium dioxide photocatalyst, TiO_2. Contaminated water flows through a reactor on which sunlight is focused to activate the catalyst forming hydroxyl radicals and super oxide ions. These reactive species readily attack and decompose organics in solution producing only water, CO_2 and halo acids. Tests have been conducted at three levels: at a benchtop scale (liter), with a small outdoor trough (100 liters) and with a large outdoor parabolic trough (2000 liters). The experimental variables examined include ultraviolet light intensity, catalyst loading, the effect of adding hydrogen peroxide, and the performance of catalyst supports. The intensity of ultraviolet irradiation significantly affected decomposition rates of a chlorinated solvent, trichloroethylene (TCE) yielding faster reaction rates at higher intensities. The amount of catalyst in suspension affected the destruction rate of trichloroethylene; the rate increased as the amount of catalyst was increased from 0.01 to 0.1 wt%. Hydrogen peroxide used in conjunction with TiO_2 significantly enhanced the photocatalytic decomposition rate of a model compound, salicylic acid, by as much as 8 times over the rate with TiO_2 alone. Supported TiO_2 on silica glass beads performed less effectively compared to suspended TiO_2 for TCE decomposition with simulated sunlight as did TiO_2 on alumina ceramic frits for decomposing salicylic acid in natural sunlight. TiO_2 on fiberglass mesh performed about as well as the ceramic frits. 20 refs., 10 figs., 1 tab.

21621 (SAND–89-7041) **High-efficiency silicon concentrator solar cell research.** Green, M.A. (New South Wales Univ., Kensington (Australia). Solar Photovoltaic Lab.); Blakers, A.W.; Jianhua, Zhao; Aihua, Wang; Milne, A.M.; Dai, Ximing; Chong, C.M. Sandia National Labs., Albuquerque, NM (USA); New South Wales Univ., Kensington (Australia). Solar Photovoltaic Lab. Dec 1989. 64p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90008040. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This project continued the development of high efficiency silicon concentrator solar cells with the goal of achieving a 24% efficient "module ready" cell. This target was comfortably achieved with efficiencies as high as 25.2% at 125 suns concentration measured at Sandia National Laboratories. In outdoor testing at Sandia, cells of this type but of more modest performance resulted in lens/cell efficiency above 20% for the first time. Exciting results were obtained with a new cell structure, the PERC cell (passivated emitter and rear cell) which demonstrated an efficiency of 21.8% for a nonconcentrating cell and creditable performance out to 20 suns for concentrator cells. Progress was also reported for cells fabricated on n-type substrates and for plasma grooved, buried contact solar cells. 22 refs., 23 figs., 9 tabs.

21622 (SERI/TR–211-3571) **$CuInSe_2$ and CdTe: Scale-up for manufacturing.** Zweibel, K.; Mitchell, R. Solar Energy Research Inst., Golden, CO (USA). Dec 1989. 109p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009503. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The information in this report was originally compiled to serve as a chapter in a photovoltaic reference book. The particular focus of this chapter was on the development of low-cost photovoltaic materials, namely $CuInSe_2$ and CdTe–two leading polycrystalline thin film materials exhibiting high efficiencies and low production costs. Both materials demonstrate significant potential as usable technologies in the commercial market. While the primary focus of this review is on the characteristics of these materials, the authors also provide a look at key methods for making these materials as well as for making added layers that are required for completing a device. In addition, the authors discuss related issues to specific materials (e.g., availability, stability, toxicity) and to each approach (e.g., advantages and drawbacks).

1406 Photovoltaic Power Systems

Refer also to citation(s) 21612, 21613

21623 (BMDSI–89-05643) **User-configurable modular PV system with microprocessor controller: Phase 3 report.** Ismail, N. Bestek Micro Devices and Systems, Inc., Ottawa, ON (Canada). Feb 1987. 30p. Contract EMR 1SZ85-00174. (MICROLOG–89-05643). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A modular photovoltaic power system has been successfully designed, constructed, and tested. There are 3 essential components to the system: lightweight plastic pluggable modules, able to be configured according to the application required; a collapsible support stand; and a microcontroller. The modules offer the advantages of easy portability, stackable storage, inexpensive mass production, ruggedness (no glass being used in their construction), and no restrictions on the size and format of the array to be built. The modules offer the possibility to generate solar power in reasonably powerful ranges (such as 10 watts). The electronic microcontroller performs the functions of data storage, system monitoring, troubleshooting, and assisting in determining the array design for a particular function. A 12-module demonstration unit was built and a number of design improvements were incorporated. 11 refs., 10 figs., 3 tabs.

1407 Solar Thermal Power Systems

21624 (N–90-14281) **Conceptual design study of a 5 kilowatt solar dynamic Brayton power system using a dome Fresnel lens solar concentrator. Final report.** Oneill, M.J.; McDanal, A.J.; Spears, D.H. Entech, Inc., Dallas-Fort Worth Airport, TX (USA). Dec 1989. 48p. (NASA-CR–185134;NAS–1.26:185134). Available from NTIS, PC A03/MF A01.

The primary project objective was to generate a conceptual design for a nominal 5 kW solar dynamic space power system, which uses a unique, patented, transmittance-optimized, dome-shaped, point-focus Fresnel lens as the optical concentrator. Compared to reflective concentrators, the dome lens allows 200 times larger slope errors for the same image displacement. Additionally, the dome lens allows the energy receiver, the power conversion unit (PCU), and the heat rejection radiator to be independently optimized in configuration and orientation, since none of these elements causes any aperture blockage. Based on optical and thermal trade studies, a 6.6 m diameter lens with a focal length of 7.2 m was selected. This lens should provide 87 percent net optical efficienty at 800X geometric concentration ratio. The large lens is comprised of 24 gores, which compactly stow together during launch, and automatically deploy on orbit. The total mass of the microglass lens panels, the graphite/epoxy support structure, and miscellaneous hardware is about 1.2 kg per square meter of aperture. The key problem for the dome lens approach relates to the selection of a space-durable lens material. For the first time, all-glass Fresnel lens samples were successfully made by a sol-gel casting process.

1409 Solar Thermal Utilization

Refer also to citation(s) 21612, 21613

21625 (DOE/CH/10093–62) **Solar buildings program summary, fiscal year 1989: Volume 1, Overview.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009477. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An estimated 29 quads of energy — the equivalent of 4.9 billion barrels of oil — are used each year in the United States to heat, cool, light, and ventilate buildings; run appliances; and heat water. This represents 37% of the nation's primary energy use at a cost of more than $200 billion annually. Although the buildings sector has made progress over the last decade in energy efficiency, an enormous opportunity remains to reduce energy operating costs, address environmental concerns, and minimize utility needs for new peak generating capacity by the use of solar technologies. Solar technologies for water heating, space conditioning, and lighting represent promising energy supply alternatives for residential and nonresidential buildings. These technologies can efficiently convert sunlight into thermal energy to closely match the temperature requirements of a variety of end uses, and they can be used directly for daylighting — reducing electricity requirements for lighting while improving occupant comfort and productivity. Although the technical feasibility of a broad array of solar buildings technologies has been clearly demonstrated — from simple solar water heaters for residences to large solar cooling systems for commercial buildings — a significant challenge remains in achieving economic competitiveness and realizing the technologies' potential to meet a large share of buildings energy requirements. The US Department of Energy (DOE) Solar Buildings Technology Program has been established to help meet this challenge. 18 figs.

21626 (DOE/SF/16306–20) **Developing, testing, evaluating and optimizing solar heating and cooling systems: Project status report, January 1, 1990–February 28, 1990.** Colorado State Univ., Fort Collins, CO (USA). Solar Energy Applications Lab. 5 Mar 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG03-86SF16306. Order Number DE90007698. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective is to develop and test various integrated solar heating, cooling and domestic hot water systems, and to evaluate their performance. Systems composed of new, as well as previously tested, components are carefully integrated so that effects of new components on system performance can be clearly delineated. The program for 1989–90 is separated into seven tasks. There are tasks for each of the three solar houses, a project to build and test several generic solar water heaters, a task involving development of an improved evacuated tube collector, a management task, and a task under which an international workshop will test IEA Task VI models. The objectives and progress in each task are described in this report.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 21621

1430 Health and Safety

21627 (SERI/TR–211-3621) **Health, safety and environmental issues relating to cadmium usage in photovoltaic energy systems.** Moskowitz, P.D. (Brookhaven National Lab., Upton, NY (USA)); Fthenakis, V.M.; Zweibel, K. Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 29p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000310. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the current technology base and hazards associated with two promising thin-film photovoltaic cells that contain cadmium compounds–cadmium telluride (CdTe) and copper indium deselenide ($CuInSe_2$). More specifically, this paper summarized the toxicological information on cadmium (Cd) compounds;evaluates potential health, safety and environmental hazards associated with cadmium usage in the photovoltaics industry; describes regulatory requirements associated with the use, handling and disposal of cadmium compounds; and lists management options to permit the safe and continued use of these materials. Handling of cadmium in photovoltaic production can present hazards to health, safety and the environment. Prior recognition of these hazards can allow device manufacturers and regulators to implement appropriate and readily available hazard management strategies. Hazards associated with product use (i.e., array fires) and disposal remain controversial and partially unresolved. The most likely effects that could be expected would be those associated with chronic low-level exposures to cadmium wastes. Because of the general immobility of the cadmium present in these devices and availability of environmental and biomonitoring protocols, chronic hazards can be monitored, and remediated if necessary. 26 refs., 5 figs., 2 tabs.

15 GEOTHERMAL ENERGY

21628 (GRSJ–8902) **1989 Annual Meeting Geothermal Research Society of Japan Abstracts with Programs.** Geochemical Society of Japan, Tokyo (Japan). 23 Oct 1989. 112p. (In Japanese). Order Number DE90752965. Available from NTIS (US Sales Only), PC A06/MF A01.

This booklet collected lectures, in abstract, given in the 1989 Annual Meeting held by the Geothermal Research Society of Japan. Totally 80 lectures are collected herein. The geological investigation comprises 'geology and physical properties of the drilling core samples from the Sengan geothermal area' and 15 other lectures. The geothermal reservoir model does 'Identification of spread and position of heat source using a porous model' and 4 others. The microearthquake does 'A study of microearthquake activities around the SN-7D well in the Sengan area' and 3 others. The thermal structure does 'Regional thermal structure of the Kuju area and its geothermal potential' and 7 others. The scale/logging does 'Silica scale inhibition by the cathodic current method' and 7 others. The geophysical exploration does 'The analysis of corresponding high-density MT measurements' and 7 others. The well test does 'Production test of exploratory well N61-SN-70, Sengan, Japan' and 3 others. The HRD does 10 lectures regarding experiments in Akinomiya and Hijiori. The goechemistry does 8 lectures regarding geothermal system in Beppu and Sengan, Japan, New Zealand, Turkey, Thailand and other regions.

1501 Resources and Availability

21629 (AD-A–214978/9/XAB) **Coso Monitoring Program, October 1987 through September 1988. Summary report, October 1987-September 1988.** Edwards, E.M.; Condon, D.E. Naval Weapons Center, China Lake, CA (USA). Apr 1989. 113p. (NWC-TP–6988). Available from NTIS, PC A06/MF A01.

The Coso Monitoring Program is a continuing effort in support of the development of the Navy's geothermal resources within the Coso Known Geothermal Resource Area (KGRA).

21630 (GSJ–8903) **Verifying surveys with geothermal exploration. Report on comprehensive evaluation (Senngan and Kurikoma Area).** Geological Survey of Japan, Tsukuba, Ibaraki (Japan). Mar 1989. 300p. (In Japanese). Order Number DE90753032. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper reports the surveyed results with geothermal exlorarting techniques at Senngan and Kurikoma areas. The deep geothermal resources were evaluated and the geothermal fluid model was constructed by comprehensive analyses through electrical exploration, MT method and well surveying. Of wells drilled in Senngann area, only SN-7D well near Akita Yakiyama arrived at excellent geothermal reservoir to result geothermal fluid exhalation, and the final stage survey was carried out around that site. Very large Yakiyama previous lake deposit of large porosity distributes under the Akita Yakiyama volcanic body which has large water holding power and reserves well meteoric water. The lower area of

the reservoir has smaller porosity but contains many fractures to the deep area, resulting superior geothermal fluid exhalation like SN-7D well. Total resource stock per block is estimated to be 9 * 10^{18}cal or more and total estimated power output in 5 blocks was 3,900MW * 30 years. Ikomayama area was also analyzed for geology, thermal structure and reservoirs, and power generating potential was 240,000kW * 30 years. 80 refs., 128 figs., 13 tabs.

21631 (LA-UR-90-698) **Hot dry rock geothermal energy – a renewable energy resource that is ready for development now.** Brown, D.W.; Potter, R.M.; Myers, C.W. Los Alamos National Lab., NM (USA). [1990]. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-900377–2: Energy and the environment in the 21st century, Cambridge, MA (USA), 26-28 Mar 1990). Order Number DE90007509. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Hot dry rock (HDR) geothermal energy, which utilizes the natural heat contained in the earth's crust, is a very large and well-distributed resource of nonpolluting, and essentially renewable, energy that is available globally. Its use could help mitigate climatic change and reduce acid rain, two of the major environmental consequences of our ever-increasing use of fossil fuels for heating and power generation. In addition, HDR, as a readily available source of indigenous energy, can reduce our nations's dependence on imported oil, enhancing national security and reducing our trade deficit. The earth's heat represents an almost unlimited source of energy that can begin to be exploited within the next decade through the HDR heat-mining concept being actively developed in the United States, Great Britain, Japan, and several other countries. On a national scale we can begin to develop this new source, using it directly for power generation or for direct-heat applications, or indirectly in hybrid geothermal/fossil-fuel power plants. In the HDR concept, which has been demonstrated in the field in two different applications and flow- tested for periods up to one year, heat is recovered from the earth by pressurized water in a closed-loop circulation system. As a consequence, minimal effluents are released to the atmosphere, and no wastes are produced. This paper describes the nature of the HDR resource and the technology required to implement the heat-mining concept. An assessment of the requirements for establishing HDR feasibility is presented in the context of providing a commercially competitive energy source.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 21630

21632 (GSJ–8902-270) **Geology, distribution of hot springs and hydrothermal alteration zones of major geothermal areas in Japan.** Geological Survey of Japan, Tsukuba, Ibaraki (Japan). 24 Mar 1989. 489p. (In Japanese). Order Number DE90753026. Available from NTIS (US Sales Only), PC A21/MF A01.

With the intention to evaluate the hydrothermal convective system geothermal resource, the existing research data in 28 major geothermal areas were prepared by the compilation works. The results of the works were collected in each areas to following figures and tables, such as (1) simplified geologic map, (2) distribution map of mineral and hot springs together with quality of spring, (3) metamorphic belts distribution map, (4) zonal distribution map of alteration zones, (5) correlation table between geologic map and compilation data, (6) catalogue for hot and mineral springs, (7) catalogue for hydrothermal alteration alteration haloes. These figures and tables showed the outline of the distribution of the geology and hot springs and metamophic belts distribution map of major geothermal areas in Japan. 616 refs., 189 figs., 82 tabs.

21633 (LA–11759-OBES) **Environmental sampling and mud sampling program of CSDP [Continental Scientific Drilling Program] core hole VC-2B, Valles Caldera, New Mexico.** Meeker, K.; Goff, F.; Gardner, J.N.; Trujillo, P.E.; Counce, D. Los Alamos National Lab., NM (USA). Mar 1990. 41p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. Order Number DE90008035. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An environmental sampling and drilling mud sampling program was conducted during the drilling operations of Continental Scientific Drilling Program (CSDP) core hole VC-2B, Valles caldera, New Mexico. A suite of four springs and creeks in the Sulphur Springs area were monitored on a regular basis to ensure that the VC-2B drilling program was having no environmental impact on water quality. In addition, a regional survey of springs in and around the Jemez Mountains was conducted to provide background data for the environmental monitoring. A drilling mud monitoring program was conducted during the operations to help identify major fluid entries in the core hole. 32 refs., 14 figs., 7 tabs.

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 21630

21634 Coring an active hydrothermal system. *Geothermal Hot Line (USA),* 18(2): 87-88 (Dec 1988).

The Valles Caldera corehole VC-2B, drilled through an active hydrothermal system at Valles Caldera in New Mexico is part of the Continental Scientific Drilling Program, funded by the US Department of Energy. The Valles Caldera hydrothermal system consists of a series of convective cells with fluid temperatures above 500°F. As the fluids move through the formation, they dissolve minerals in the high-temperature areas and redeposit them in the low-temperature areas. The study was designed to examine the active ore-deposition process. Study data are gathered from cores taken from the surface to total depth at 5,780 feet, including about 600 feet of Precambrian granitic rock at the bottom of the hole.

21635 Fiber-optic sensors and geothermal reservoir engineering. Angel, S.M. (Lawrence Livermore National Lab., CA (USA)); Kasameyer, P.W. *Geothermal Hot Line (USA),* 18(2): 89-90 (Dec 1988).

Perhaps the first demonstrations of fiber-optic sensors in a geothermal well occurred in early 1988 on the Island of Hawaii. The first of two fiber-optic optrode tests was at the HGP-A well and 3-megawatt power plant facility managed by the Hawaii National Energy Institute at the University of Hawaii. The second test was in a nearby geothermal exploratory well, Geothermal Test Well 2. Both sites are in the Kilauea East Rift zone. A fiber-optic temperature sensor test will be undertaken soon in a deeper, hotter geothermal well. Problems will be examined that may occur with a stainless steel-sleeved, fiber-optic cable. The paper describes fiber optic technology and its use in geothermal reservoir engineering.

21636 US Department of Energy FY 1990 Congressional budget request: Conservation and renewable energy. *Geothermal Hot Line (USA),* 18(2): 91 (Dec 1988).

Geothermal Energy program activities include the joint development of instruments, equipment, materials, techniques, models, and systems; they provide a ready means of rapid, efficient technology transfer. A table summarizes actual funding for GY 1987 and 1988, estimated funding for FY 1989, and requested funding for FY 1990 for the following geothermal activities: geopressured research; hydrothermal industrialization; geothermal technology development: (a) hard rock penetration research, (b) reservoir technology, (c) conversion technology, (d) hot dry rock research, (e) magma energy; capital equipment; and program direction.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21631

21637 Geothermal monies from Petroleum Violation Escrow Funds. *Geothermal Hot Line (USA),* 18(2): 92 (Dec 1988).

To date, about $3.6 billion of Petroleum Violation Escrow Funds (PVE) have been disbursed to state energy offices by the US Dept. of Energy for use in energy-related programs that mainly encourage energy conservation or the use of renewable energy. Most of the funds resulted from two cases: the Exxon Decision and the Stripper Well Settlement Agreement. The specific allocation of these funds within various candidate state programs is left to the

discretion of the individual state, but requires final review and approval of the DOE for consistency with the terms of the settlement agreements. Colorado and South Dakota are conducting geothermal projects using PVE funds. At least one other state (Arizona) has considered applying PVE funds to geothermal projects. However, other nongeothermal activities that are being conducted in several states represent types of projects that could be relevant to geothermal power production, district heating/cooling, and/or direct use projects.

1506 Environmental Aspects

Refer also to citation(s) 21631

21638 (DOE/NV/10174–5, pp. 1-49) **Water quality monitoring.** Trahan, D.B. Louisiana State Univ., Baton Rouge, LA (USA). Dec 1985. In *Technical support for geopressured-geothermal well activities in Louisiana. Final report, 1 November 1983-31 October 1984.* Order Number DE86012779. Available from NTIS, PC A06/MF A01.

Several methods have been used to separate natural water quality variations from man-induced variations in the analyses of water samples from geopressured-geothermal prospects in southwestern Louisiana. Concentration-versus-time curves, ratio comparisons, and ternary plots have served to distinguish saltwater intrusion from drilling fluid or brine contamination. At the Rockefeller Refuge prospect, surface waters illustrate a negative trend in concentrations of seawater components that may be due to clay mineral flocculation, cation exchange, or adsorption and absorption properties. Chemical analyses of ground water from the shallow aquifer show higher concentrations of seawater components than those from the deeper aquifer, indicating the connection of the shallow aquifer to the surface. Drilling fluid contamination is also evident in ground waters during the drilling phase. Regional trends in water quality are evident in ternary plots. The main trend is a transition from fluvial waters at Parcperdue to marine waters at Rockefeller Refuge. Sweet Lake waters, which border the uplands and marsh lands, fluctuate between these two extremes. Depth of ground water is also a distinguishing characteristic in the regional analysis. The water quality classification schemes in this study are useful for determining the effects of geopressured-geothermal development on the quality of fresh waters. Concentration-versus-time curves and ionic ratios are most useful in local contamination studies, and ternary plots are effective in regional characterizations.

21639 (DOE/NV/10174–5, pp. 50-72) **Subsidence monitoring.** Trahan, D.B. Louisiana State Univ., Baton Rouge, LA (USA). Dec 1985. In *Technical support for geopressured-geothermal well activities in Louisiana. Final report, 1 November 1983-31 October 1984.* Order Number DE86012779. Available from NTIS, PC A06/MF A01.

Subsidence monitoring networks around geopressured-geothermal prospects in southwestern Louisiana have been in place for five years. Repeated leveling surveys within these networks allow for a comparison of elevation changes for benchmarks between leveling epochs. A paper discussing the results of subsidence monitoring at Parcperdue and Rockefeller Refuge was presented at the Sixth US Gulf Coast Geopressured-Geothermal Energy Conference in February 1985. This paper has been included in this report as an appendix at the end of this section. In summary, general subsidence rates measured at all test sites are small, ranging from −0.12 in./yr (4 mm/yr) at Parcperdue to −0.55 in./yr (14 mm/yr) at Rockefeller Refuge. The greater subsidence rates at Rockefeller Refuge are considered to be related to the natural compaction of surficial marsh land clays. The surface geologic unit at Parcperdue consists of sand and gravel and is hence less susceptible to compaction.

21640 (DOE/NV/10174–5, pp. 73-111) **Microseismic monitoring.** Stevenson, D.A. Louisiana State Univ., Baton Rouge, LA (USA). Dec 1985. In *Technical support for geopressured-geothermal well activities in Louisiana. Final report, 1 November 1983-31 October 1984.* Order Number DE86012779. Available from NTIS, PC A06/MF A01.

Continuous microseismic monitoring networks have been established around three US Department of Energy (DOE) geopressured-geothermal design wells in southwestern Louisiana since summer 1980 to assess the effects well development may have on subsidence and growth fault activation. The results obtained from this monitoring have shown several unusual characteristics associated with Gulf Coast seismic activity. The observed activity is classified into two dominant types, one with identifiable body phases and the other with only surface wave signatures. The latter type comprises over 99% of the reported 1000+ microseismic event locations. The problem with the slow-moving surface-wave signature events is that rainfall and weather-associated frontal passages seem closely related to these periods of seismic activity at all three wells. After relatively short periods and low levels of flow testing at the Parcperdue and Sweet Lake prospects, seismic monitoring has shown little credible correlation to inferred growth fault locations during periods of flow testing. Longer periods and higher volumes of flow testing at the Rockefeller Refuge prospect should provide a truer indication of induced seismicity attributable to geopressure-geothermal development.

1509 Geothermal Engineering

Refer also to citation(s) 21635, 21636

1510 Direct Energy Utilization

21641 Geothermal direct use engineering and design guidebook. Lienau, P.J.; Lunis, B.C. vp.Oregon Institute of Technology, Klamath Falls, OR (US) ([1990]).

The use of low- and moderate-temperature (50 to 300°F) geothermal resources for direct use applications has increased significantly since the late 1970s. As a result of this growth, and the need for state-of-the-art information on geothermal direct use project development, the Geothermal Direct Use Engineering and Design Guidebook was published. The book contains 20 chapters titled: Introduction; Demonstration projects lessons learned; Nature of geothermal resources; Exploration for direct heat resources; Geothermal fluid sampling techniques; Drilling and well construction; Well testing and reservoir evaluation; Materials selection guidelines; Well pumps; Piping geothermal fluids; Heat exchangers; Space heating equipment; Heat pumps; Absorption refrigeration; Greenhouses; Aquaculture; Industrial applications; Engineering cost analysis; Regulatory and commercial aspects; and Environmental considerations.

1520 Geothermal Data and Theory

Refer also to citation(s) 21538

21642 Chemistry of submarine hydrothermal solutions from sediment covered ridge crests. Von Damm, K.L. (Oak Ridge National Lab., TN (USA)). pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). DOE Contract AC05-84OR21400. (CONF-8806309–: Symposium on organic matter in hydrothermal systems: maturation, migration and biogeochemistry, Toronto (Canada), 5-10 Jun 1988).

Within the last decade the discovery of hydrothermal solutions exiting from the oceanic crust along the world ridge crest system has caused a revision in models describing controls on seawater chemistry. Due to reaction with basalt at elevated temperatures, the chemistry of the hydrothermal seawater is greatly modified, becoming an acidic, reducing fluid. Several areas of the ridge are sediment covered and these solutions undergo additional reactions before exiting at the sea floor. These solutions have a characteristically different chemistry from those which react with basalt alone; the $CaCO_3$ and organic matter in the sediments being especially important. Experimental studies are also aiding the separation of the sedimentary from the basaltic imprint in these solutions.

16 TIDAL AND WAVE POWER

1604 Economic, Industrial, and Business Aspects

21643 (ATPPB–89-05743) **Assessment of retiming tidal power from Bay of Fundy using compressed air energy storage.** Atlantic Tidal Power Programming Board (Canada). Mar 1988. 141p. Contract EMR 48SZ 23283-7-6131. (MICROLOG–89-05743). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The objective of the study is to examine the economic viability of using compressed air energy storage (CAES) to retime cyclic power from the proposed tidal power plant at the mouth of Cumberland Basin in the Bay of Fundy. The study objective was met by preparing prefeasibility level cost and energy estimates based on conceptual arrangements of air compressor, generating plants and underground storage facilities, and relating these estimates to the potential marketability of the retimed power and energy. The CAES system in general is outlined and then the CAES system for the site is described: equipment, geological aspects in constructing the plant, and economic and marketing factors and estimates involved are also given. The report examines: alternative tidal power/CAES installations, CAES systems, and marketability. The study concludes that it is feasible to implement the proposal, based on readily available equipment and methodology, but the use of the compressed air energy system proposed to provide additional energy stoage from utilities is unlikely to be economically attractive. 26 figs., 11 tabs.

1605 Environmental Aspects

21644 (AUI–34) **Development of hydrodynamic model in Cumberland Basin for tidal power applications: Final report.** Margerie, S. de (ASA Consulting Ltd., Dartmouth, NS (Canada)); DeWolfe, D. Acadia Univ. Inst., Wolfsville, NS (Canada). Mar 1987. 110p. Contract EMR 41ST.23216-5-7326. (MICROLOG–89-05994). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report describes the use of a fine-grid, three dimensional hydrodynamic model which is used to describe the tidal and current patterns in Cumberland Basin in the Bay of Fundy for both the natural regime and a regime modified by the installation of a tidal power barrage (A8) between Peck's Point and Boss Point. The model was used to assess the impact of the A8 tidal power project on the tidal regime of Cumberland Basin. This model and the associated data base should provide the best basis for impact studies of tidal power development on the ecosystem, sediment and morphological regimes of Cumberland Basin, as well as to study the effects on turbidity distribution and benthic and pelagic organisms. Tidal parameters for Cumberland Basin and a new consolidated bathymetric data set are formed. An examination of available data, as well as a theoretical analysis, has shown that tidal flows dominate the hydrodynamic regime of Cumberland Basin. The data sets generated in this study include simulated water levels and velocity coefficients. Some data sets of further interest and general interest are: analysis of post barrage stratification potential using the H/U^3 method and computation of effective flushing times, horizontal and vertical mixing rates. Computation of turbulent energy distribution, Calculation of the 3-D residual and tidal flow patterns through selected cross-sections.

17 WIND ENERGY

1701 Resources and Availability (Climatology)

Refer also to citation(s) 21653

1704 Economic, Industrial, and Business Aspects

21645 (RV–T4-W10) **A study on Wind Energy Conversion Systems (WECS), cost evaluation, and prospects for cost reduction: Final report.** Resource Ventures, Inc., Charlottetown, PE (Canada). Sep 1987. 72p. Contract EMR 03SQ.23440-5-7050. (MICROLOG–89-05958). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

To determine the present cost to manufacture and install wind energy conversion systems and to identify opportunities for potential reduction in these costs a survey of major European and North American manufacturers was made to obtain wind energy conversion systems (WECS) component cost data and other information relative to their production cost. Thirty manufacturers surveyed, nine horizontal axis wind turbine (HAWT) and two vertical axis wind turbine (VAWT) manufacturers volunteered data and information. The results indicate that significant progress in cost reduction is being made and that there is further opportunity. A 60% reduction in installed costs has been realized during the 1982-1987 and industry estimates a further 17% reduction in 1988. The study indicates that emphasis in design should be placed on lighter weight structures and maximum use of commercially available components. It appears the lowest cost HAWT design will use integral speed increaser/chassis assemblies and truss or lattice type towers. The study indicates that VAWT design must move to lighter weight structures and commercially available drive train components. Indications were obtained that WECS ratings for minimum annual levelized cost of energy will settle out between 300 kW and 1000 kW. 4 figs., 8 tabs.

1706 Wind Energy Engineering

21646 (INDAL–89-05736) **Structural modelling of Darrieus rotor wind turbines with hinged blades and stabilizing struts: Final report.** Indal Technologies, Inc., Mississauga, ON (Canada). [1989]. 63p. Contract EMR 23216-6-6244. (MICROLOG–89-05736). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report presents the findings of a study of the structural mechanics of two-bladed Darrieus rotor wind turbines which are equipped with vertically-oriented hinges that allow the blades to move out of the plane of the rotor. The study examines, in particular, the structural dynamic behaviour of the Adecon 19-m rotor and a hypothetical Indal 6400 modified to incorporate hinged blades. Finite element models were used to simulate the behaviour of both turbines. The report summarizes two earlier reports which were concerned with the Adecon 19-mm rotor only. The report also presents full details of the natural frequencies, the frequency response (during normal operation), and the response to transients of the modified Indal 6400. The conclusions of the study are that, while the inclusion of blade hinges may reduce some of the out-of-plane response during operation, the in-plane stresses are not attenuated. The result is a modest decrease in the maximum rms of cyclic stresses. The advantage that accrue during normal operation may be offset by the difficulty of limiting peak stresses during braking. The flexible struts examined for the modified Indal 6400 must be restrained by other stiffer and stronger members during this transient condition. 7 refs., 33 figs., 5 tabs.,

21647 (INDAL–89-05741) **Improving the design and economics of Darrieus rotor wind turbine: Report on tasks 5 and 6: Cost estimates. Final report.** Indal Technologies, Inc., Mississauga, ON (Canada). Apr 1987. 52p. Contract EMR 23216-6-6167. (MICROLOG–89-05741). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report presents the final results of a study of the feasibility of improving the cost effectiveness of Darrieus rotor wind turbines. The key feature of the inmprovement is the incorporation of tailored airfoils whish have been designed (and proven) to limit the maximum power developed by the rotor. In this way a larger area may be swept and more energy extracted from the wind without increasing the (considerable) costs of the drive train, electrical generators and connections, foundations, and necessary services. Two new rotors have been designed and arrangement drawings have been prepared. One rotor is limited to using a blade obtainable as a single aluminum extrusion while the second rotor incorporates a step-tapered blade and larger chord dimensions. The cost and energy production of each based on a 20-machine installation at two Canadian locations (Magdalan Islands and Prince Edward Island), is compared with equivalent costs for the existing Indal 6400 wind turbine. Results show that the greatest cost of energy decreases are associated with the second rotor (with tapered blades) and lower wind regimes. For the Prince Edward Island location, a cost of energy decrease of 21% is anticipated. It is recommended that further (detailed) design concentrate on the rotor with tapered blades and that special attention be given to the design of blades, their connections, and aerodynamic fairings. 7 refs., 13 figs., 9 tabs.

21648 (INDAL–89-05744) **Testing of the Indal 6400 VAWT strut modification: Final report.** Indal Technologies, Inc., Mississauga, ON (Canada). Jul 1988. 40p. Contract EMR 23216-6-6011. (MICROLOG–89-05744). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A research and development program was initiated to modify the Indal Technologies 6400 series 500kW vertical axis wind turbine (VAWT) located at the Atlantic Wind Test Site in Prince Edward Island. The modifications to the VAWT were a significant departure from the previous designs. The strut compliance was accomplished solely by flexing of the strut itself instead of by a mechanical spring and damper assembly. Additional local reinforcement of the blade was accomplished using structural adhesives bonding aluminum to aluminum. The results to date have been very good. All the natural frequencies are within 5% of those predicted by the computer model, and worst case fatigue life predicaions agree well with the design life goal. The single I-beam strut assembly is considerably cheaper than the previous rigid strut with mechanical spring coupler. It is also much simpler since it has no moving parts to fail. The adhevise bonding of reinforcing plates on the plates on the blades adds cost, but adds considerably to the fatigue life. One conclusion is that the strut could have been slightly stiffer, since the critical area of the rotor is now the blade root. Future minor modifications should further improve the fatigue life. 15 figs., 2 tabs

21649 (MH–18706011) **Examination of alternative foundation designs for remote wind/diesel systems.** Morrison Hershfield Ltd., North York, ON (Canada). 16 Apr 1987. 37p. (MICROLOG–89-05636). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study on wind turbine foundation systems considers a system using a Howden HWP60 horizontal axis machine, operating in conditions typical of northern Ontario. The design wind load corresponds to a maximum steady wind speed of 58 m/s at 20 m height. There are 3 main variables to be considered in selecting the appropriate design: the soil conditions, the frost conditions, and the availability of materials and skilled labor. The load bearing capabilities of muskeg, weak cohesive soils, stiff cohesive soils, granular soils, weathered rock, and sound rock are discussed. Precautions necessary for conditions of seasonal freezing, discontinuous permafrost, and continuous permafrost are described. The installation procedures in this study take into account the difficulties of transporting materials to remote areas where heavy equipment cannot be used and where local labor is generally unskilled. The types of foundations are the shallow concrete footing, steel grillage, timber grillage, piles, screw anchors, rock anchors, and ring beam foundations. Each type of foundation is appropriate for certain kinds of soil conditions, and the need for insulation has to be assessed for each individual site in conjunction with the selection of the type of footing. 21 refs., 11 figs., 2 tabs.

21650 (PB–90-855701/XAB) **Wind turbines and generators for wind power plants. January 1976-April 1985 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1976-April 1985.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 147p. Available from NTISPC N01/MF N01.

See also PB–90-855719.

This bibliography contains citations concerning the design, development, testing, controlling, and performance characteristics of a variety of wind turbines and generators used in conjunction with wind power plants. Some consideration is given to economic issues, hybrid systems, and power grid integration studies. (This updated bibliography contains 188 citations, none of which are new entries to the previous edition.)

21651 (PB–90-855719/XAB) **Wind turbines and generators for wind power plants. May 1985-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for May 1985-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 107p. Available from NTISPC N01/MF N01.

Supersedes PB–85-858140. See also PB–90-855706.

This bibliography contains citations concerning the design, development, testing, controlling, and performance characteristics of a variety of wind turbines and generators used in conjunction with wind power plants. Some consideration is given to economic issues, hybrid systems, and power grid integration studies. (This updated bibliography contains 212 citations, all of which are new entries to the previous edition.)

21652 (SERI/TP–257-3663) **PC-based PCM telemetry data reduction system software.** Simms, D.A. Solar Energy Research Inst., Golden, CO (USA). Feb 1990. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900599–3: 36. ISA international instrumentation symposium, Denver, CO (USA), 6-10 May 1990). Order Number DE90000317. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Solar Energy Research Institute's (SERI) Wind Research Program is using pulse code modulation (PCM) telemetry systems to study horizontal-axis wind turbines. SERI has developed a low-cost PC-based PCM data-acquisition system to facilitate quick PCM data analysis in the field. The SERI PC-PCM system consists of AT-compatible hardware boards for decoding and combining PCM data streams and DOS software for control and management of data acquisition. Up to four boards can be installed in a single PC, providing the capability to combine data from four PCM streams direct to disk or memory. This paper describes the SERI Quick-Look Data Management Program, which is a comprehensive software package used to organize, acquire, process, and display information from PCM data streams. The software was designed for use in conjunction with SERI's PC-PCM hardware described in a related paper. Features of the Quick-Look program are highlighted, including those which make it useful in an experiment test environment to quickly examine and verify incoming data. Also discussed are problems and techniques associated with PC-based PCM data acquisition, processing, and real-time display. 7 refs., 4 figs., 2 tabs.

21653 (TES–C937-14) **Prospecting site technical summary for 1987/88.** TES Ltd., Ottawa, ON (Canada). Jun 1988. 77p. Contract EMR 54SZ.23216-6-6129. (MICROLOG–89-05742). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The existence of good windy areas and the application of modern technology have indicated that there is a relatively good

potential for the use of wind energy conversion systems in Canada. In April 1981, TES Limited was contracted by the National Research Council of Canada to analyze data on wind speed distribution and potential outpur from a vertical axis wind turbine (VAWT) from numerous wind prospecting and generating sites across Canada. The data collection was continued until 1986, or 1988 for the three last sites. The instrumentation used for collecting wind regime data varied somewhat among the sites, but, in general, consisted of an anemometer mounted on a 20 m tower and an electronic histogram recorder, which samples wind speeds every 2 s and stores the resulting data as counts in bins representing various wind speed ranges. The wind regime data thus received were analyzed to characterize the wind parameters for each site, with particular attention being paid to wind speed characteristics, and to the available wind energy and potential turbine output based on a nominal 50 kW VAWT. This report summarizes the data obtained from the three active prospecting sites for the calendar year 1987 (Universite Sainte Anne, Rattlesnake Hill, and Rankin Inlet), and also summarizes the data obtained for 28 sites from the beginning of the program. 1 ref., 31 figs., 9 tabs.

20 FOSSIL-FUELED POWER PLANTS

21654 (PCCIM–CE02873, pp. 22.1-22-11, Paper 22) **Power plants and cogeneration plants.** Iyer, R.S. (ICF Kaiser Engineers, Oakland, CA (USA)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

In most industries, the non-energy related costs are optimised; this together with the lack of new, large utility power plants, has encouraged independent power producers to develop and build small power plants. In some cases where there is also a need for the thermal energy, these power plants have been operated in a cogeneration mode. This paper discusses the technical and business options which are available when developing a non-utility power plant or cogeneration plant. Also discussed are the energy costs of various industries, the technology options (engines, gas turbines, steam turbines and combined (topping) cycles with or without waste heat utilizations) and the business issues fo power generation (power purchase agreement,fuel purchase contract, thermal energy contract, operations and maintenance contract, and project financing). Most industries that produce electrical power by self-generation or co-generation do so to negotiate a better rate for the energy purchased from the utility, to be independent from the utility, and to provide electrical power during load peaks, thereby reducing the demand charge paid to the utility.

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Refer also to citation(s) 21141, 21154, 21160, 21169, 21171, 21172, 21173, 21174, 21175, 21177, 21852, 21863, 21876, 22062, 22109, 22208

21655 (EPRI-GS–6673-Vol.2) **R&D plans for advanced computer and control technologies: Volume 2, Instrumentation and control systems: Final report.** Vasudeva, K.S. (Bailey Controls Co., Wickliffe, OH (USA)); Penland, J.R.; McKinley, J.; Sleezer, D.; Skedzielewski, D. Electric Power Research Inst., Palo Alto, CA (USA); Bailey Controls Co., Wickliffe, OH (USA); Science Applications International Corp., San Diego, CA (USA); Gilbert/Commonwealth, Inc., Reading, PA (USA); Integrated Systems, Inc., Palo Alto, CA (USA). c Feb 1990. 357p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report describes a five year research and development plan which addresses the need to improve instrumentation and control systems in fossil fired power generating plants. The plan represents the combined effort of electric power utility representatives, the Electric Power Research Institute (EPRI), EPRI contractors and a variety of suppliers and consulting engineers. The plan consists of a set of projects to improve the design, selection, and implementation of advanced control systems which can improve the competitive position of utilities by lowering the cost of power production. The plan has been developed to serve several purposes: to serve as a guide for the direction of EPRI I&C R&D programs over the next five years; including project identification, scheduling and funding requirements, justification, expected benefits, etc.; to enable the utility fossil power generation industry to monitor and evaluate R & D projects in terms of the industry needs; and to serve as a reference document for the utility fossil power generation industry in identifying project areas, project completion schedules, and technology transfer methods. Potential projects for the plan were identified by utilities according to important needs. A quantitative evaluation of the potential projects included a factor for priority, cost/benefit ratio, and project duration time.

21656 (EPRI-GS–6673-Vol.3) **R&D plans for advanced computer and control technologies: Volume 3, Expert-systems technology assessment: Final report.** Duggan, P. (Expert-EASE Systems, Inc., Belmont, CA (USA)); Sopocy, P.M.; Kozlik, G.; Sudduth, A.; Davis, J.; Guy, K.; Anzolut, T.; Mitchell, P. Electric Power Research Inst., Palo Alto, CA (USA); Expert-EASE Systems, Inc., Belmont, CA (USA); Sargent and Lundy, Chicago, IL (USA); Science Applications International Corp., San Diego, CA (USA). c Feb 1990. 253p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Power plant management is finding it increasingly challenging to meet the combined goals of net generated output, efficiency, reliability, and availability. Realizing these goals is becoming increasingly difficult for utilities in light of the continually increasing targets for these goals that must be set across the industry in response to today's more competitive market and demanding regulatory overview. The amount of information that must be digested, interpreted, and acted upon by plant operators to command the maximum performance from a plant while remaining responsive to all of these goals is becoming overwhelming and is rapidly expanding. Implementation of expert systems technology promises to help utilities reach these goals by assisting personnel in the management and interpretation of today's information explosion. This report provides a plan for an organized program of expert system application development that is designed to advance the implementation of expert systems technology throughout the utility industry. This plan has been developed through the efforts of a formal working group comprised of key representatives of utilities, manufacturers, architect/engineers, and consultants having experience in expert systems development. The results of a screening process by which the best prospective expert system applications were identified are presented in the form of summaries that address the need, advantages, limitations, research methodology, estimated costs and benefits, and commercialization potential of each application. Detailed ratings are presented for each of these applications, along with a resultant ranking and prioritization for development and implementation.

21657 (EPRI-GS–6673-Vol.4) **R and D plans for advanced computer and control technologies: Volume 4, Process integration and information systems for fossil plant automation: Technology assessment; Final report.** Ipakchi, A. (Science Applications International Corp., San Diego, CA (USA)); Wong, D.J.; Wells, B.; Skedzielewski, D.; Taft, C.; Valli, J. Electric Power Research Inst., Palo Alto, CA (USA); Systems Control, Power Automation, Inc., Palo Alto, CA (USA); Science Applications International Corp., San Diego, CA (USA). c Feb 1990. 220p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Competition, rising cost, and changes in technology have prompted many US electric utilities to consider new methods of power plant operation. One approach is the introduction of automation in an effort to increase productivity, reliability, efficiency, flexibility, and performance. The rapid advancement of computer technology has opened new opportunities for more sophisticated control and monitoring than ever before. The application of automation, though, has been through the use of a deluge of independent, specialized systems dedicated to specific needs. The

utilities' quick adoption of these systems for solving specific problems has created "Islands of automation". These islands cannot pass information or communicate with one another. Each requires their own separate computer and terminal. The redundancy of data and sensors in order to collect needed information for each independent system have added to the confusion in the plant. These independent systems have rapidly pushed the key issue of integration to the forefront for plant automation. There is still a need for further development of techniques and technologies for plant automation, but the key issue is integration. This report presents the results of an EPRI sponsored study and planning project. The purpose of this project was to identify the current automation issues facing the utility power industry, and to develop a seven year R & D plan for EPRI in this area. In addition to the R & D plan, the report presents the results of a survey, and discusses topics such as plant-wide automation systems' architecture, communications, and man-machine interface. 25 refs., 33 figs., 13 tabs.

21658 (EPRI-GS–6776) **GADSRAM user's manual: Version 2.0: Final report.** Dougan, K.W. (Arinc Research Corp., Annapolis, MD (USA)); Hall, S.C. Electric Power Research Inst., Palo Alto, CA (USA); Arinc Research Corp., Annapolis, MD (USA). c Mar 1990. 158p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This User's Manual is intended to accompany Version 2.0 of the computer software package, GADSRAM, which has been developed to provide an automated means for converting plant performance, outage-event, and design data into a UNIRAM input file. This manual presents the steps necessary to set up the GADSRAM system on a microcomputer, discusses the input data preparation requirements, and describes the eight execution options available to the user. It details the GADSRAM system functions and provides direction to the user for performing the necessary interactions with the program. 5 figs., 4 tabs.

21659 (OH/RD–89-98-K) **Methods for measuring the air heater leakage in a coal fired thermal generating station.** Chang Shinnder. Ontario Hydro Research Div., Toronto, ON (Canada). 30 May 1989. 18p. (MICROLOG–90-00410). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

The tracer gas technique can be used to measure the air leakage to the flue gas in the air heater of a cole fired thermal generating station but the results must be verified if poor mixing is encountered. Because there is no possibility of direct measurement through conventional instrumentation, an indirect method is needed. Two methods, one based on the carbon dioxide balance and the other based on the oxygen balance were developed in this work to meet the need. Compared to the tracer gas technique the new methods employed no external tracer gas thus there is less of a mixing problem. They are especially useful to compare the test results of one method with that of others to improve the confidence of the findings. 6 figs.

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Refer also to citation(s) 21159, 22513, 22524

21660 (DOE/PC/88867–T5) **Electrostatic precipitation of condensed acid mist: Phase 1, Final report, September 1988–September 1989.** Dahlin, R.S. Southern Research Inst., Birmingham, AL (USA). Nov 1989. 35p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88867. (SRI-ENV–89-1054-6657-16). Order Number DE90006171. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Southern Research Institute is developing a compact, wet electrostatic precipitator (WESP) to control acid mist missions from high-sulfur coal combustion. The WESP is being developed as a retrofit technology for existing coal-fired power plants, particularly those equipped with wet flue gas desulfurization (FGD) scrubbers. Acid mist emissions can be a significant problem at these facilities because the sulfuric acid vapor in the flue gas is converted to a very fine mist that is not collected in the scrubber system. Conventional mist eliminators are not adequate in this application due to the very fine size of the mist droplets. The potential for corrosion also makes it difficult to use a fabric filter or a conventional, dry ESP in this application. Therefore, this research project has been structured around the development of a compact WESP that could be retrofit on top of an existing scrubber or within an existing flue gas duct. This paper describes the development and testing of a prototype WESP for the utility acid mist application. Testing was conducted with combustion of sulfur-doped gas to simulate the acid mist alone, and with a combination of coal and sulfur-doped gas to simulate the mixture of acid mist and fly ash downstream from a scrubber. The performance of the WESP test unit was modeled using two different cylindrical-geometry computer models: a "current-seeking" model and a "current-specific" model. 8 refs., 15 figs., 7 tabs.

21661 (EPRI-GS–6711) **An investigation of precipitator wide plate spacing: Final report.** Wheeler, H.L. (Combustion Engineering, Inc., Birmingham, AL (USA). Environmental Systems Div.); Farr, A.L.; DuBard, J.L.; Landham, E.C. Jr. Electric Power Research Inst., Palo Alto, CA (USA); Combustion Engineering, Inc., Birmingham, AL (USA). Environmental Systems Div.; Southern Research Inst., Birmingham, AL (USA). c Feb 1990. 239p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents the results of a study to assess the feasibility of using precipitators with wide plate spacing on coal-fired utility boilers in the United States. The study consisted of parametric evaluations of various plate spacings in a pilot ESP; performance tests of a utility ESP with wide plate spacing; tests of the interelectrode electric potential distribution; and commercial evaluations of the feasibility of wide plate spacing. The economic study indicated that the capital cost of a new precipitator can be reduced by 12% to 16% when the plate spacing is increased from 9 inches to 18 inches. Furthermore, the reduction in the number of ESP components should reduce the maintenance cost and improve the reliability. In the major effort of the study, the performance of the pilot ESP at the EPRI Arapahoe Test Facility was tested with plate spacings of 9, 12, 18, and 22 inches, and with different values of fly ash electrical resistivity and average gas velocity. The ESP was operated at spark limit for all tests, and the operating voltages increased proportionally as the plate spacing was increased form 9 to 18 inches. When the variations in ESP performance due to variations in fly ash resistivity were removed from consideration, analysis of the performance data indicated that there was little or no loss in collection efficiency as the plate spacing was increased from 9 to 18 inches, even though the collecting plate area and SCA were halved. The ESP performance degraded at 22-inch plate spacing. In addition to the pilot-scale study at Arapahoe, the performance of a German utility fly ash precipitator with both conventional and wide plate spacings in different fields was tested with selected fields turned off.

21662 (OH/RD–89-42-K) **A review of hydrogeological and geochemical data from three Ontario Hydro fly ash disposal sites.** Vorauer, A. Ontario Hydro Research Div., Toronto, ON (Canada). 21 Jun 1989. 51p. (MICROLOG–90-01169). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A review of hydrogeological and geochemical data collected from 3 Ontario Hydro fly ash disposal sites was completed. This review was conducted to assess the environmental impact of fly ash landfilling on the groundwater regimes at Booth Quarry in Etobicoke, Canada Brick Quarry in Mississauga, and Birchwood Park in Clarkson, Ontario. Fly ash has been in place at the above sites from 3-17 years, and different landfill designs and practices were used at each one. Geologically, the Booth Quarry and the Canada Brick Quarry are located in shale bedrock which is a favourable environment for fly ash landfilling. The Birchwood Park site, located in a former sand and gravel pit, has not been as successful. Based on the data collected to date, no significant degradation of local

groundwater quality has taken place, however continued monitoring of hydraulic heads and water quality is recommended until equilibrium conditions have been reached. The use of fly ash as a structural fill material has allowed for the reclamation of land for recreational and development programs in the large urban centres of the Toronto area. 10 refs., 22 figs., 2 tabs.

21663 (OH/RD–89-66-K) **Properties of waste by-products from limestone (lime) dual alkali and limestone (lime) wet scrubbing processes: A literature study.** Chan, H.T. Ontario Hydro Research Div., Toronto, ON (Canada). 19 May 1989. 157p. (MICROLOG–90-00403). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This literature study deals with the chemical, physical and mechanical properties of the waste by-products from the limestone(lime) dual alkali scrubbing process and the limestone(lime) wet scrubbing process. The properties under study are mineralogy and composition, particle size distribution, density, moisture content, Atterberg's limits, pH value, compaction characteristics, shear strength characteristic, permeability, compressibility, and consolidation characteristecs. These properties of the untreated and stabilized wastes from flue gas desulfurization were gathered to gain a better understanding of their properties and behaviour for the design and operation of a future Ontario Hydro solid waste management system, as well as to determine the potential utilization/market in options of these wastes. The limestone dual alkali and the limestone wet scrubbing processes are briefly described. The engineering properties of the untreated sludges/filter cakes generated by the dual alkali and the wet scrubbing processes are summarized, as are those of the stabilized sludges/filter cakes generated by the limestone dual alkali, lime dual alkali, and limestone wet scrubbing processes. The chemical properties of the wastes generated by the dual alkali and the wet scrubbing processes are summarized. Brief discussions on the fixation processes for the flue gas desulfurization wastes and examples of utilization of these stabilized wastes are included. Recommendations are made for further research. 49 refs., 50 figs., 40 tabs.

21664 (OH/RD–89-117-K) **Assessment of Substitute N_2O in flue gas.** Edwards, G.C.; Handy, B. Ontario Hydro Research Div., Toronto, ON (Canada). 9 Jun 1989. 36p. (MICROLOG–90-01170). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

An assessment of N2O levels in the flue gas of coal-fired power plants was undertaken. The role of N2O in the atmosphere, the present state of knowledge of N2O in flue gas, and N2O measurement techniques are discussed. As part of the assessment, measurements of N2O emissions at Nanticoke Thermal Generating Station in Ontario were carried out on May 18 and 19, 1988. Average concentrations of 23 and 21 ppm were mesured at the economizer and air heater outlets respectively. N2O:NOx molar ratios of less than 7% were observed. These N2O:NOx ratios are substantilally less than those presently used to estimate the contribution of N2O by the utility industry to the global N2O budget. These results are considered preliminary and further sampling is recommended to confirm these numbers. 20 refs., 16 figs., 8 tabs.

21665 (OH/RD–89-183-K) **Physical properties of a fly ash slurry: A laboratory investigation.** Chan, H.T. (Ontario Hydro, Toronto, ON (Canada)). Ontario Hydro Research Div., Toronto, ON (Canada). 22 Aug 1989. 42p. (MICROLOG–89-06322). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A laboratory testing program was undertaken to assess some physical properties of a pumpable fly ash slurry prepared by mixing fly ash with water. Several types of tests were conducted to study the mixing, flowability, strength characteristics and the resistance to wind erosion of the fly ash. The main objective of this investigation was to obtain physical data make a decision on the practicality of pumping ash to a disposal site and to assist in the design of the site if the decision to go ahead was made. The laboratory test was comprised of three main parts. A study done on the effect on slurry flowability of mixing fly ash by air bubbling indicated a slight loss of flowability due to evaporation. The strength characteristics of cured ash (partially dried ash slurry) was studied as well as its resistance to wind erosion. The main results were as follows: Ash slurry cured at room temperature showed improved resistance to wind erosion. Frozen slurry had little dusting problems, however mechanical disturbance of the frozen surface could cause a sinificant problem. Wind erosion increased on surfaces distubed by rain and freezing. The strength of partially air-dried ash at temperatures above freezing are sufficient not to cause stability problems with a retaining dyke. After freezing, the strength could be quite low. Any disposal site should be designed so that water from thawed ash could be drained quickly. 4 refs., 17 figs., 5 tabs,

21666 (PB–90-501008/XAB) **Development of the National Acid Precipitation Assessment Program (NAPAP) National Utility Reference File (NURF) emissions inventory, 1985, Version 2 (for microcomputers). Data file.** Wagner, J.K.; Rothschild, S.S. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. vp. Available from NTISCP D02.

See also PB–88-137153 and PB–88-137138. The data file is contained on 5 1/4-inch diskette, high density (1.2M), compatible with the IBM AT microcomputer. The diskettes are in the LOTUS 1-2-3 format. Price includes documentation, PB–90-132341.

The Lotus 123 file contains the variables listed below for all steam electric-generating units in the U.S. that are at least 25 MW in size. All data represent the year 1985. Data variables included in the file are the following: state, county, plant name, DOE plant code, operating utility, Unit No., NAPAP identification code, capacity factor, capacity, year online, primary fuel, SO2 emission rate, Btus consumed, SO2 emissions, SO2 removal efficiency, NOx removal efficiency, bottom type, firing type, NOx emissions, NOx emission rate, and primary NOx control device.

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21667 (OH/RD–89-65-K) **Estimates of air pollutants concentrations and deposition due to electricity exports during the period 1991-2006.** Melo, O.T.; Lin, X.; Wright, S.; Selorio, P. Ontario Hydro Research Div., Toronto, ON (Canada). 23 Jun 1989. 84p. (MICROLOG–90-01172). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

Ontario Hydro is preparing an application for a license to export electricity to the USA from 1991-2006. This application must cover the social costs incurred in Canada by generating electricity for export. The calculation of social costs involves assessments of air pollutant concentrations and deposition due to all sources and to electricity exports alone, the relationship between pollutant dose and receptor response, and the cost associated with the incremental dose due to electricity exports. This report considers the assessment of the air pollutant concentrations and deposition associated with emissions from fossil-fuel-fired stations. Concentrations and deposition were estimated through the use of pollutant transport and deposition models, suitable for both short- and long-range transport. To apply these models, representative meteorological data were selected, and 1980-82 emissions data were adopted as a baseline which was then modified to take into account the implementation of acid rain control legislation in Eastern Canada and Ontario Hydro's projections of export sales. The long-range transport calculations indicate that Ontario Hydro's contribution to ambient concentrations and deposition of S and N species at sensitive receptor areas is <5% and that at most 30% of this contribution is due to the proposed electricity exports. On a local scale, the contribution of Lambton, Nanticoke and Lakeview power stations to air pollutant concentrations is somewhat higher, particularly at Nanticoke. Results are given in both annual and seasonal

averages to facilitate the calculation of seasonally-dependent impacts. 29 refs., 41 figs., 11 tabs.

21668 (OH/RD–89-138-K) **Atikokan TGS [thermal generating station] aquatic studies, 1981 to 1988. 3 . Plankton and macrophytes.** Kwik, J.K.; Dunstall, T.G. Ontario Hydro Research Div., Toronto, ON (Canada). 26 Jun 1989. 125p. (MICROLOG–90-01171). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This report presents the results of the primary production, phytoplankton, zooplankton and macrophyte studies conducted as part of the postoperational aquatic studies at Atikokan Thermal Generating Station, Ontario, in 1987 and 1988. They are compared to data collected during the preoperational (1981-83) and commissioning (1985) phases, and 1986 postoperational studies, to identify changes in components of the aquatic environment which may be related to the construction or operation of the generating station. Primary production was more uniform throughout the water circuit following establishment of the cooling circuit. Differences in the phytoplankton data among study years may be due to natural annual variation and/or artifacts of infrequent sampling rather than station operation. Comparison of zooplankton data collected during the pre- and postoperational years suggests that station operation has not resulted in any obvious changes in the zooplankton that can be distinguished from year-to-year variation. Water drawdown during the preoperational period resulted in increased growth of E. canadensis and the concurrent disappearance of water lilies from Snow Lake. There has been a gradual increase in the distribution of the macrophytes since the stabilization of water levels in the cooling circuit in 1982. In addition, their density has increased steadily since the station started operating. 29 refs., 52 figs., 14 tabs.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21941

21669 (ORNL/TM–11295) **Estimation of nonfuel operation and maintenance costs for advanced circulating fluidized-bed and advanced natural gas-fired combined cycle power plants.** Coen, J.J.; Bowers, H.I.; Myers, M.L. Oak Ridge National Lab., TN (USA). Dec 1989. 56p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. Order Number DE90008084. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Operation and maintenance cost estimating methodologies for advanced coal-fired atmospheric circulating fluidized-bed and advanced natural gas-fired combined cycle electric power plants are presented. The purpose of these cost estimating relationships is for use in long range planning and evaluation of the economics of use of these technologies for electric power generation. Projected annual costs of reference plants at ten different sites in the United States, one in each of the ten DOE regions, are given as of 1989, and comparisons are made with existing technologies. A listing of a computer program implementing the methodologies is included. 14 refs., 4 figs., 13 tabs.

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Refer also to citation(s) 22544

21670 (IAEA-TECDOC–524, pp. 55-68) **An integrated safety goal concept.** Sniezek, J.H. (Nuclear Regulatory Commission, Washington, DC (USA)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

In early 1983, the U.S. Nuclear Regulatory Commission published a safety goal policy to set forth its views on what constitutes an acceptable level of safety for the operation of commercial nuclear power reactors in the United States (NUREG-0880). The safety goal was to be evaluated over a 2-year period. The evaluation period ended in April 1985. As expected, several controversial issues were identified during the evaluation. These primarily involved the extent to which NRC should require safety improvements that (1) would primarily reduce the overall frequency of severe core-damage/core-melt accidents (independent of the severity of offsite health risks) and (2) would serve to benefit the plant owners by averting the onsite economic costs of such accidents. To help resolve these issues, the NRC staff is considering an approach that would integrate the three principal safety goal decision elements (i.e., the core-melt frequency, public mortality risks and the benefit - cost algorithm). Use of this integrated approach in implementing the final policy on safety goals is now under active discussion. A commensurately higher monetary ceiling would be applied to those plants that exhibit because of either design or operation, a higher than normally expected level for the core-melt frequency. A monetary incentive would thus exist for plant owners to promote safety in plant design and operations. The principal conclusions reached during the safety goal policy evaluation, the integrated safety goal concept and the prospective implementation of a safety goal policy in the U.S. are described in detail in the paper. It is anticipated that the Commission will decide on these matters and the final safety goal policy statement during 1986. 11 figs.

21671 (IAEA-TECDOC–524, pp. 95-103) **Status of probabilistic safety criteria in France.** Candes, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The paper reviews the use of probabilistic approach to NPP safety in France. It introduces the limits of 10^{-6}/yr as the global probability for unacceptable consequences and 10^{-7}/yr for each particular family of adverse events. Complementary measures to impose the safety level for some specific situations are described. An example of safety improvements introduced for the loss of electric supply is given. (author). 1 ref.

21672 (IAEA-TECDOC–524, pp. 117-123) **The Swedish view of probabilistic safety criteria - Present status.** Carlsson, L. (Swedish Nuclear Power Inspectorate, Stockholm (Sweden)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Today we do not have a formal Probabilistic Safety Criterion. However, extensive use of PSA on all plants is promoted. The safety work in Sweden is divided into two areas: first, core damage preventing activities, and second, severe accident phenomena. In this paper the Swedish authorities' recommendation to the Swedish Government and an overview of the Swedish reliability evaluation program (ASAR-AS operated Safety Analysis Report) is included. The last part of the paper gives some results from Swedish PSA work. (author). 1 fig., 1 tab.

21673 (IAEA-TECDOC–524, pp. 125-136) **Development of the non-dimensional method of ranking risks.** Chicken, J.C. (J.C. Consultancy Ltd, Godalming, Surrey (UK)); Hayns, M.R. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic

safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

This paper presents a critical review of the progress that has been made in the development of the risk ranking technique. The aim of the development of the technique has been to produce a method of making a comprehensive assessment that takes into account the technical, economic and socio-political factors involved in determining the acceptability of a risk. The paper shows how the ranking of the risks associated with two major projects can be determined. The process of building up the ranking includes a critical examination of the data available and the methods used for deriving the ranking from such data. The paper is divided into three parts. Part one examines in general terms the data that is likely to be available for ranking acceptability. Part two demonstrates by ranking the Moss Morran liquefied energy gas facility and the liquefied natural gas facility proposed for Eemshaven how the technique can be used in practice. Part three assesses the efficacy of the technique in its present state of development and reflects on the possible future role of the technique. The future uses suggested for the technique include both as an aid to regulatory policy making and as a management tool. (author). 14 refs, 4 tabs.

21674 (IAEA-TECDOC–524, pp. 137-163) **A method to incorporate uncertainty and degree of compliance in safety goals.** Hayns, M.R. (UKAEA Safety and Reliability Directorate, Culcheth (UK)); Unwin, S.D. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

We propose a method for the construction of quantitative regulatory safety goals that are compatible with current risk assessment and uncertainty evaluation techniques. The concept of 'degree of compliance' is introduced in order to reflect the vagueness inevitably attached to any reasonable notion of 'safety' underlying a safety goal. The logical and general procedure for comparing risk assessment with safety goal produces data in a convenient and transparent format designed to facilitate regulatory decision making. (author). 8 refs, 12 figs.

21675 (IAEA-TECDOC–524, pp. 165-176) **Prospects for probabilistic safety criteria (PSC).** Niehaus, F. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Safety). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Many countries are developing PSCs. At first glance the various proposals which have been made look very different and include core-melt probabilities, individual risk levels, limit-lines for societal risk and probability density functions for individual exposure to radiation. Most of these proposals are highly controversial and at present subject to an analysis of their implications for actual safety decisions. Also the "first principles" which are being used for PSC developments vary considerably; ranging from comparisons to societal risk levels in general, comparisons to risks of competing energy technologies to comparison to radiation risks from normal operation. This paper suggests that the various approaches are not as different as one might infer and explores the possibilities to develop an integrated hierarchical framework for PSCs in accordance with various objectives. (author). 4 figs, 6 tabs.

21676 (IAEA-TECDOC–524, pp. 177-181) **The use of probabilistic methods in the licensing of nuclear power plants: A recent example.** Baeverstam, U. (National Inst. of Radiation Protection, Stockholm (Sweden)); Wiktorsson, C. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

In 1981 the Swedish government decided that the nuclear power plant at Barsebaeck in southern Sweden should be provided with filtered ventilation. The main reason was to prevent severe ground contamination in case of an accident. A ventilating device was connected in late 1985. The Government also decided that no later than 1989 all other Swedish power plants should be provided with some kinds of devices assuring as good a protection for the population around these plants as around Barsebaeck. In handling this matter and the licencing questions connected to it our institute has partly relied upon probabilistic methods and considerations. In short, the following actions have been taken: The power plant owners have supplied our institute with results from systematic reliability studies (involving probabilistic arguments) and some preliminary suggestions for solutions. Combining these with results from probabilistic studies performed by ourselves and with a number of criteria for acceptance of risk (some of which probabilistic) we have formulated some conditions that must be fulfilled before licencing of the arrangements required. In the last stage of the process the plant owners are supposed to use as one tool probabilistic arguments to make sure that the conditions are fulfilled. The paper presents the working process in some details, with the emphasis put on the probabilistic approaches. (author).

21677 (IAEA-TECDOC–524, pp. 183-194) **Use of reliability and risk standards as bases for acceptance in licensing and regulation of nuclear power plants.** Virolainen, R. (Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The prevention and mitigation of accidents in PWR and BWR type reactor plants is essentially based on the sufficient operability of certain primary safety systems. To ensure sufficient reliability, the authority sets forth numerical reliability goal for the most important safety functions of new nuclear power plants. The unreliability of the function in question shall remain below this goal. To calculate the reliability of systems, one uses a data base which has been collected from the operating experiences of similar plants. If a data base of this kind is not available, a generic data base is utilized. However no fixed numerical acceptance standards are set forth in advance for the probabilities of a core melt, but the estimated probabilities are compared with the known probabilities of a core melt at other nuclear power plants. As concerns the operating plants it is defined in the Technical Specifications under what conditions the operation of the plant can be continued when faults have been detected in components important to safety. However, the Technical Specifications do not cover all situations in plant operation. Especially if there is a hidden potential fault discovered after the commissioning of the plant, for example an initiating event that may damage systems important to safety, the decision concerning the shutdown of the plant and the urgency of the repair must be made utilizing a probabilistic criteria. In cases like this, the authority requires that the power company estimate the annual risk of a core melt caused by the safety deficiency in question. The authority will perform an independent estimate and considers the shutdown of the plant and the urgency of the repair by comparing the risk of a core melt caused by the safety deficiency with the risk of a core melt estimated in connection with the PSA. 2 refs, 2 figs, 1 tab.

21678 (IAEA-TECDOC–524, pp. 195-204) **Comparison of different societal risks: A new limit-line concept.** Munera, H.A. (Swiss Federal Inst. of Technology, Zurich (Switzerland). Nuclear Engineering Lab.). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Many of the proposed and/or adopted quantitative safety criteria for nuclear power plants (NPPs) are based on limit-lines, somehow related to frequency-consequence (f-C) curves as reviewed by the author elsewhere (Munera and Yadigaroglu, 1985). An alternative interpretation of the same statistical data identifies two random components for each societal risk, namely: 1. The total number of accidents N during the observation period T. Although its probability distribution may be unknown, the accident rate $\lambda = N/T$ provides a convenient descriptor. 2. The conditional probability distribution of X, given that an accident has occurred. A plot of $F^* = n/N$ vs X immediately gives the empirical complementary cumulative probability distribution function (CCPDF). In the context of this model, it is obvious that f-C curves are but plots of λF^* vs X (Munera, 1985). We re-analysed under the previous model the empirical data collated by Coppola and Hall (1981) for natural disasters (hurricanes, floods, earthquakes, tornadoes) and technological accidents (transport, mining, fire and explosion) with the following results: a. There is no particular pattern for λ, which spans a rather short interval: 4 to 24 events/year for the total world, and 0.1 to 5 events/year for the USA. b. There is a striking pattern for the total world plots of F^* vs X. Indeed, three regions are clearly identified: natural disasters (above), technological accidents (below), and an intermediate empty zone. It is suggested that the envelope of technological accidents constitutes a societally maximum tolerable technological accident (MTTA). Finally, for regulatory purposes it is necessary to aggregate F^* and λ. (Abstract Truncated)

21679 (IAEA-TECDOC–524, pp. 205-209) **Approach to PSA methods and probabilistic safety criteria in licensing of nuclear power plants in the Federal Republic of Germany.** Gottschalk, P. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The paper addresses the following questions: To what extent are PSA's used in nuclear safety? Does a risk approach imply a philosophical change in the traditional methods of design and regulations? Are PSA's formally incorporated in the licensing procedure and does the Federal Republic use, or does it plan to use, some type of quantitative probabilistic safety criteria or risk targets? (author).

21680 (IAEA-TECDOC–524, pp. 211) **The regulatory use of probabilistic safety analysis in Argentina.** Gonzalez, A.J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

This paper describes the regulatory use of probabilistic safety analysis by the Argentine competent authority. A historical background of the use of probabilistic approaches in the Argentine nuclear safety programme is presented. A probabilistic safety criterion enforced by the authority for the purpose of licensing nuclear power plants is described. The logics of the criterion is based on probabilistic safety goals derived from the individual-related requirement of the dose limitation system used for radiation protection purposes. The use of the criterion in the licensing process of the Atucha II Power Plant is described. Finally, the paper analyzes the limitation of the criteria, as an individual-related requirement, to take appropriately into account the overall expected impact from the source and the theoretical difficulties involved in the implementation of the criteria. (author).

21681 (IAEA-TECDOC–524, pp. 213) **Prospect theory and limit lines.** Wu-Chien Jya Syin (California Univ., Los Angeles, CA (USA). School of Engineering and Applied Science); Apostolakis, G. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Risk acceptance criteria in the form of limit lines are investigated in the context of prospect theory. This theory departs from utility theory in several respects, an important one being the use of weights other than probabilities in the evaluation of the expected impact of uncertain outcomes. Hypothetical functions reflecting certain attitudes toward consequences and rare events are developed and combined to produce several limit lines. (author).

21682 (IAEA-TECDOC–524, pp. 215) **Risk aversion in risk acceptance criteria.** Wu-Chien Jya Syin (California Univ., Los Angeles, CA (USA). School of Engineering and Applied Science); Apostolakis, G. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The risk averse attitude that is included in some proposal risk acceptance criteria is examined. It is shown that it is a weaker attitude than risk aversion, as is commonly defined in decision theory. Consequently, the boundary curve separating acceptable and unacceptable regions does not have to be a straight line on the logarithmic frequency-consequence space. A curve of variable slope would express the same attitude as long as the slope is less than -1. (author).

21683 (IAEA-TECDOC–524, pp. 217) **Risk management application of fire risk analysis.** Kazarians, M. (Pickard, Lowe and Garrick, Inc., Newport Beach, CA (USA)); Siu, N.; Apostolakis, G. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Probabilistic risk assessment (PRA) has shown that the contribution of fires to the frequency of core damage and radionuclide release in some nuclear power plants can be significant. This article discusses the use of PRA results in fire risk management. The decomposition of these results leads to the identification of the most important contributors to the risk and, thus, allows for the identification of potential modifications that can have the greatest impact on risk. This paper discusses the process of generating these options and offers several insights that have been gained from an actual study. (author).

21684 (IAEA-TECDOC–524, pp. 219-227) **PRISIM - A computer program that makes PRA useful.** Fussell, J.B. (JBF

Associates, Knoxville, TN (USA)); Campbell, D.J.; Glynn, J.C.; Burdick, G.R. International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

PRISIM is an IBM personal computer program that translates probabilistic risk assessment (PRA) information and calculates additional PRA type information for use by those who are not PRA experts. Specifically, PRISIM was developed for the U.S. Nuclear Regulatory Commission for use by their resident inspectors at nuclear power plants. Inspector activities are either scheduled or are in response to a particular status of a plant. PRISIM is useful for either activity. PRISIM also contains vast amounts of preprocessed information relevant to inspection planning and inspector training. In addition to instantly available licensee event report data, dominant accident sequence explanations and other data base information, PRISIM has routines that are directly related to the NRC inspection modules, i.e., the guidelines for scheduled inspection activities. For each module, PRISIM provides all the PRA type information that can be useful in making decisions required in executing the module activities. New component "importance" measures had to be derived for this portion of the program. PRISIM is the most advanced software of its type available. All information is virtually instantaneously available even though a 20 mega bite hard disk is required for storing the information for one plant. The first version of PRISIM was developed for the Arkansas Nuclear One - Unit 1 (ANO-1) Plant and is currently being updated to reflect the plant's changes that have been made to the design since the PRA for ANO-1 was completed. This paper describes PRISIM and its application to ANO-1 in detail. 3 figs, 1 tab.

21685 (IAEA-TECDOC–524, pp. 229-232) **CEC task force on safety goals: Summary. .** International Atomic Energy Agency, Vienna (Austria); Commission of the European Communities, Brussels (Belgium). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

After consultation within the Working Group on the Safety of Light Water Reactors, the Commission of the European Communities appointed a special group (February 1982) with the task to report on the status of the need, possibilities and limitations for/of overall safety objectives for nuclear power plants. The mandate of this so called Task Force on safety goals/objectives included the following: To consider on a technical basis the need, possibilities and limitations of overall safety objectives for nuclear power plants, taking stock of various trial-approaches. To examine the merits and implications of the various approaches and to determine the degree of coherence and the divergencies in their possible applications. To summarise this by establishing a status report which comprises an outline of the degree of coherence and of the divergencies in the experts opinions. Depending on the outcome of item (1) to (3) advise the CEC on how and to what extent feed-back into USA-efforts presently underway is opportune and feasible.

21686 (IAEA-TECDOC–524, pp. 233-238) **Some questions on the development of probabilistic safety criteria.** Higson, D.J. (Australian Atomic Energy Commission, Kings Cross, New South Wales (Australia). Australian Safeguards Office). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The paper addresses some basic questions, related to the development of probabilistic safety criteria, including: (1) Is it possible to use the same criteria for nuclear and non-nuclear safety? (2) What type of health effects should the criteria be based upon? (3) What form should the criteria take? (4) How should optimization be applied? (author). 1 fig.

21687 (KTA-GS–12(1989)) **KTA collection of terms and definitions. As of June 30, 1989. To replace publication KTA-GS–12 dated January 16, 1987.** Riedel, U. (comp.). Kerntechnischer Ausschuss (KTA), Koeln (Germany, F.R.). [1989]. 144p. (In German). Order Number DE90759361. Available from NTIS (US Sales Only), PC A07/MF A01.

The collection of definitions mainly comprises terms which are laid down in the recommendations of the Nuclear Engineering Committee (KTA) or in overriding regulations and specifications. The collection aims at a KTA-standardized use of terms and at the avoidance of groundless divergences. The compiled definitions are followed by a list of the sources considered, namely laws, ordinances, administrative recommendations, KTA regulations as well as other recommendations and standards. (orig.).

21688 (ORNL/FTR–3540) **[Small and Medium-Size Reactor Expert Group]: Foreign trip report, February 9–14, 1990.** Rowan, W.J. Oak Ridge National Lab., TN (USA). 5 Mar 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90008371. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler represented the US DOE in recent meetings of OECD's Small and Medium-Size Reactors (SMR) Expert Group. The following topics were addressed at the meetings: (1) progress on the accomplishments of the group's study; (2) review of draft material for various sections of the Group's report; (3) changes in the structure and content of the report; and (4) assignments and schedules to assure that the report will be issued on time.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 21704, 21714, 21715, 21738, 21743, 21788, 21791, 21794, 21799, 21804, 21807, 21810, 21811, 21813, 21814, 21815, 21818, 21819, 21821, 21823, 21824, 21825, 21828, 21829, 21830, 21831, 21833, 21834, 21835, 21838, 21839, 21840, 21842, 21844, 21845, 21848, 21849, 21850, 21851, 22281

21689 (EPRI-NP–6701) **Simulator requirements manual: Final report.** Roessner, D.C. (Roessner (D.C.), Nescopeck, PA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Roessner (D.C.), Nescopeck, PA (USA). c Feb 1990. 117p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Since the NRC has begun requiring Nuclear Power Plant simulators, several documents have been officially published with simulator requirements and simulator good practices. The objective of this project is to separate written requirements from opinion or interpretation. This document presents simulator requirements in an indexed and a comparative form. In addition to indexing the requirements, an example of how these requirements can be synthesized into a decision making process has been provided. Finally, simulator upgrade versus new procurement considerations are examined. The central idea behind simulator certification is to clearly document simulator performance, thus allowing the NRC to determine to what degree the simulator meets 10 CFR 55 and ANSI/ANS 3.5 requirements (as modified by Regulatory Guide 1.149). Understanding and complying with the requirements can only save time and money for both the government and the industry. The requirements are set forth as part of this project. 3 refs., 1 fig.

21690 (NUREG–0975-Vol.6, pp. 1-76) **Heavy-section steel technology program.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The Heavy Section Steel Technology program is carried out to advance the understanding and validation of materials and structures behavior as they relate to light-water reactor pressure vessel integrity. The program contributes to verifying the applicability of fracture mechanics to vessel integrity assessments, to advancing associated analysis tools, to data generation and correlations development, and to code criteria and rule development and validation. The studies address the determination of the effects of flaws, variations in properties, stress raisers, and residual stresses on the integrity of vessels under combined thermal and mechanical loading. Flaw-growth mechanisms, crack-propagation characteristics, crack-arrest behavior and the effects of irradiation are considered for both design and accident-loading conditions. The data from the program are used in regulatory guides, codes and standards, federal regulations and the evaluation process for specific safety issues that include irradiation effects on pressure vessels and their supports, the influence of low-shelf weld-metal on fracture potential, overcooling-accident evaluations, crack-arrest methodology, environmentally assisted crack growth, probabilistic fracture mechanics and the influence of stainless steel cladding on flaw behavior.

21691 (NUREG–0975-Vol.6, pp. 107-131) **Degraded piping program - Phase II. Battelle Columbus Division.** Ahmad, J.; Barnes, C.; Brust, F.; Guerrieri, D.; Kramer, G.; Landow, M.; Marschall, C.; Nakagaki, M.; Papaspyropoulos, V.; Scott, P. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The overall objective of the Degraded Piping Program is to verify and improve simple estimation schemes to predict the fracture behavior of circumferentially cracked pipe. The program is limited to quasi-static fracture and cracks in straight pipe. There are a variety of materials, flaw geometries, pipe sizes, and loading conditions evaluated. In 1987, many topical reports were completed on the following work packages: leak-before-break analysis of cracked pipe; significance of results on in-service flaw acceptance criteria; and impact of material characterization evaluation and unusual fracture modes.

21692 (NUREG–0975-Vol.6, pp. 132-150) **Elastic-plastic fracture mechanics evaluation of light-water-reactor (LWR) alloys.** Hackett, E.M. (David Taylor Research Center, Annapolis, MD (USA)); Hays, R.A.; Davis, D.A.; Joyce, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

Objectives of this project were to characterize the J-R curve and tearing instability behavior of 8 inch diameter A106 steel pipe containing circumferential welds; develop and standardize a testing technique applicable to pressure vessel and piping alloys; verify and extend the modified J-integral concept for R curves to cover varying specimen types and to assess material and size effects; and to characterize the fracture behavior of A533B steel in the transition region using a dynamic J approach.

21693 (NUREG–0975-Vol.6, pp. 151-172) **LWR pressure vessel surveillance dosimetry improvement program.** McElroy, W.N.; Gold, R.; Guthrie, G.L.; Kellogg, L.S.; Matsumoto, W.Y.; Preston, C.C.; Ruggles, J.M.; Simons, R.L.; Roberts, J.H.; Oliver, B.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this program is to make measurements in neutron fields (Benchmark and reactor Test and Surveillance Regions) for the subsequent validation/calibration of available state-of-the-art physics-dosimetry-metallurgy, damage correlation, and the associated reactor analysis procedures and data. These procedures and data are in turn used for predicting the integrated effects of neutron exposure to LWR-PV and support structure steels from results of research reactor tests and power reactor surveillance programs. The program work includes: (1) selection of the neutron fields, (2) validation/calibration of physics-dosimetry-metallurgy, damage correlation, and the associated reactor analysis procedures and data using these fields, (3) preparation and editing of a series of 20 supporting NUREG reports, and (4) preparation and establishment of a set of 21 ASTM-recommended standard Practices, Guides, and Methods.

21694 (NUREG–0975-Vol.6, pp. 269-281) **Long-term aging embrittlement of cast duplex stainless steels in LWR systems.** Chopra, O.K. (Argonne National Lab., IL (USA)); Chung, H.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The primary objectives of this program are (1) to investigate the significance of in-service embrittlement of cast duplex stainless steels under light water reactor (LWR) operating conditions, and (2) to evaluate possible remedies to the embrittlement problem for existing and future plants. The scope includes the following: (1) characterize and correlate the microstructure of reactor-aged and long-term laboratory-aged material with loss of fracture toughness to identify the mechanism of embrittlement, (2) conduct Charpy-impact, tensile, and J-R curve tests on these materials to characterize the loss of fracture toughness, and (3) evaluate the effects of key compositional and metallurgical variables on the kinetics and degree of embrittlement. Effort during the past year has focused on characterization of the microstructure and fracture morphology of reactor- and laboratory-aged materials, recovery anneal of embrittled material, and the mechanical properties of aged cast stainless steel.

21695 (NUREG–0975-Vol.6, pp. 292-316) **Evaluation and improvement in nondestructive examination (NDE) reliability for in-service inspection of light water reactors.** Deffenbaugh, J.D.; Good, M.S.; Green, E.R.; Heasler, P.G.; Simonen, F.A.; Spanner, J.C.; Taylor, T.T. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The evaluation and improvement of NDE Reliability for In-service Inspection (ISI) of Light Water Reactors (NDE Reliability) Program at Pacific Northwest Laboratory (PNL) was established to determine the reliability of current ISI techniques and to develop recommendations that will ensure a suitably high inspection reliability. The objectives of this NRC program are to: determine the reliability of ultrasonic ISI performed on commercial light-water reactor (LWR) primary systems; determine the impact of NDE unreliability on system safety and determine the level of inspection reliability required to ensure a suitably low failure probability using probabilistic fracture mechanics analysis; evaluate the degree of reliability improvement that could be achieved using improved and advanced NDE technique; and recommend revisions to ASME Code, Section XI, and Regulatory Requirements, based on material properties, service conditions, and NDE uncertainties, that will ensure suitably low failure probabilities. The program consists of three basic tasks: a Piping task, a Pressure Vessel task, and an Evaluation and Improvement in NDE Reliability task. The major efforts were concentrated in the Piping task and the Evaluation and Improvement in NDE Reliability task.

21696 (NUREG–0975-Vol.6, pp. 317-325) **Acoustic emission - flaw relationships for in-service monitoring of nuclear reactor pressure boundaries.** Hutton, P.H.; Kurtz, R.J.; Friesel, M.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The acoustic emission (AE) development program addresses the objective of validating technology for continuous monitoring of reactor pressure boundaries and components to detect cracking. The work is supported by the NRC Research Office with the Tennessee Valley Authority providing supplemental funding. The FY 1987

scope includes the following items: (1) Initiate continuous, on-line AE monitoring of three sections of Watts Bar, Unit 1 reactor (currently instrumented) during operation; (2) Complete continuous, on-line AE monitoring of cracked pipe locations at Peach Bottom 3 reactor; (3) Complete refinement of AE signal identification and AE/flaw evaluation methods; (4) Complete intergranular stress corrosion cracks (IGSCC)/AE testing and validate AE signal identification and flaw evaluation methods applicable to IGSCC monitoring; (5) Complete investigation of the influence of low crack growth rate on detection of crack growth AE and flaw evaluation using the AE data; (6) Complete ASTM approval of a Standard Practice for Continuous Monitoring of Acoustic Emission from Metal Pressure Boundaries; (7) Submit a Code Case/Appendix to ASME Section XI for acceptance of continuous AE monitoring as a method for inspection of pipes and nozzles, and for general on-line monitoring of the entire pressure boundary; (8) Complete a review draft of a final program summary report; and (9) Prepare semi-annual progress reports and topical reports as appropriate.

21697 (NUREG–0975-Vol.6, pp. 326-337) **Development and validation of a real-time SAFT-UT system for in-service inspection of LWRs.** Hall, T.E.; Reid, L.D.; Mart, G.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

A multi-year program is underway at Pacific Northwest Laboratory (PNL) to move the synthetic aperture focusing technique (SAFT) from the laboratory into the field for the purpose of inspecting light-water reactor (LWR) components. The objectives of the program are: Design, fabricate, and evaluate a real-time flaw detection and characterization system based on SAFT-UT (ultrasonic testing) for in-service inspection of all required LWR components; Establish calibration and field test procedures; and Generate an engineering data base to support Code acceptance of the real-time SAFT-UT technique. The FY-1987 scope included: (1) Complete the SAFT-UT field system; (2) Complete the real-time SAFT processor and documenting its performance; (3) Evaluate the SAFT-UT field system in a blind test; (4) Adapt the tandem SAFT mode to thick-section steel applications; (5) Conduct SAFT system sensitivity studies; (6) Develop mechanisms for transferring the SAFT technology to the industry; and (7) Conduct field validation tests.

21698 (NUREG–0975-Vol.6, pp. 338-346) **Evaluation of advanced and current leak detection systems.** Kupperman, D.S. (Argonne National Lab., IL (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this project is to assess the reliability of leak detection technology for LWRs and evaluate advanced acoustic leak detection concepts for detection, location, and characterization of leaks. The FY 1987 scope includes: (1) Completing update of review of reliability of leak detection systems; (2) Completing evaluation of acoustic leak detection for in-reactor detection, discrimination, and location of leaks through laboratory testing of valves and cracks (including integranular stress corrosion cracks (IGSCCs)) with leak rates of 1-10 gal/min; (3) Completing evaluation of techniques to discriminate crack leaks from valve and seal leaks; and (4) Prepare draft document (guidance manual) for acoustic leak monitoring of reactor primary systems.

21699 (NUREG–0975-Vol.6, pp. 405-417) **Effect of decontamination on aging processes and considerations for life extension.** Diercks, D.R. (Argonne National Lab., IL (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this program is the development of information on the long-term effects of successive decontaminations of reactor piping and steam generators, coupled with thermal aging, on the safety-related performance of these components during extended life. Results from this program will provide input for making decisions on plant life extension and program will provide input for making decisions on plant life extension and will integrate with the overall program for nuclear plant aging research. This program will assess the possible adverse effects of repeated chemical decontaminations on the remaining service life of aged components in light-water nuclear reactors (LWRs). The aging processes under consideration include the low-temperature sensitization of stainless steels, the long-term embrittlement of cast duplex stainless steels, and radiation-induced embrittlement of reactor internal components. A literature survey of experience with the chemical decontamination and chemical cleaning of LWR components, particularly after extended service, is presently underway. This will be followed by an experimental program that will address those areas where safety questions have been raised or insufficient data are available.

21700 (NUREG/CR–5450) **High-temperature crack-arrest tests using 152-mm-thick SEN wide plates of low-upper-shelf base material: Tests WP-2.2 and WP-2.6.** Naus, D.J. (Oak Ridge National Lab., TN (USA)); Keeney-Walker, J.; Bass, B.R.; Iskander, S.K.; Fields, R.J.; deWit, R.; Low, S.R. III. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA); National Inst. of Standards and Technology, Gaithersburg, MD (USA). Feb 1990. 115p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11352). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Two 152-mm-thick wide-plate crack-arrest tests (WP-2 series) are discussed in this report. Each test used a 1 x 1 x 0.15 m thick single-edge-notch specimen (a/w = 0.2), fabricated from a low-upper-shelf base material, that was subjected to a linear thermal gradient along the plane of crack propagation. The tests were conducted at the National Institute of Standards and Technology and were designed to provide fracture-toughness measurements at temperatures approaching or above the onset of the Charpy upper-shelf regime in a rising toughness region and with an increasing driving force. Results obtained from these tests have produced crack-arrest toughness values well above the limit recognized by the current ASME guidelines (220 MPa $\cdot \sqrt{m}$) with arrests occurring at 44 to 102°C above the material DW_{NDT} (60°C). The fracture data support (1) the use of fracture mechanics concepts to analyze cleavage run-arrest events, (2) the treatment of cleavage run-arrest and ductile fracture modes as separate events, and (3) the fact that cleavage arrest occurs above the ASME limit. 124 refs., 83 figs., 18 tabs.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 21689, 21690, 21691, 21692, 21693, 21694, 21695, 21696, 21697, 21698, 21699, 21700, 21714, 21715, 21737, 21738, 21741, 21742, 21743, 21787, 21788, 21791, 21794, 21798, 21799, 21800, 21804, 21805, 21806, 21807, 21808, 21809, 21810, 21813, 21816, 21817, 21818, 21819, 21821, 21823, 21825, 21827, 21829, 21830, 21831, 21832, 21835, 21836, 21838, 21839, 21840, 21841, 21842, 21843, 21844, 21845, 21847, 21848, 21849, 21850, 22109, 22281

21701 (IAEA-TECDOC–524, pp. 105-115) **Status of probabilistic safety criteria in Italy.** Ferreli, A. (Italian Directorate for Nuclear Safety and Health Protection (ENEA-DISP), Rome (Italy)). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

An extensive use of probabilistic techniques has been requested for the PUN, the Italian PWR standard plant. The Italian Regulatory Body issued in 1983 a set of General Design Criteria (GDC) where quantitative targets in terms of effective dose equivalent for the members of the public have been established for the different plant

conditions grouped in probability ranges. With regard to events beyond design basis accidents a design objective has been fixed in terms of maximum overall probability for the complex of sequences that could lead to degraded conditions. In order to verify compliance with the above established targets a Probabilistic Safety Study (PSS) has been performed. The methodology used is similar to that described as level 1 PRA in NUREG/CR-2300 "PRA Procedure Guide"; the analysis considers only internal and area events, whereas external hazards, both natural and man-made, were excluded. The weakest points in the design were discovered through sensitivity and partial importance analysis, and plant design modifications have been proposed in order to achieve the probabilistic goal. The PUN-PSS shall be considered as an interactive tool to be developed and updated together with the design and on the basis of the outcomings of the licensing process. In this way the PUN-PSS appears as a "living schedule" continuously updated and therefore valid to evaluate the safety level of the plant and to support at any moment every decision. A possible set of criteria for the reassessment of severe accidents and the definition of new source terms for regulatory purposes to be used could be established in the near future. A specific study to evaluate the containment response and reliability upon core melt has been carried out by the Italian Regulatory Body for plants representative of the most common containment schemes. (Abstract Truncated)

21702 (NUREG–0975-Vol.6, pp. 77-106) **Structural integrity of light water reactor pressure boundary components.** Loss, F.J.; Cullen, W.H.; Hawthorne, J.R.; Hiser, A.H.; McCabe, D.E.; Menke, B.H.; Terrell, J.B. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

This program of applied research provides analytical and experimental methods and data that are necessary to ensure the structural safety and reliability of pressure boundary components in commercial light water reactor power systems. Emphasis is placed on characterization of material properties performance in a nuclear environment for application to plant aging, plant-life extension, and mitigation of the consequences of postulated accident scenarios. Current work is organized into three major tasks: (1) fracture mechanics investigations, (2) environmentally-assisted crack growth in high temperature, reactor primary water, and (3) radiation sensitivity and postirradiation properties recovery. The approach centers on experimental characterization of nuclear grade steels and an assessment of fracture and fatigue behavior under conditions of a nuclear environment where investigation of irradiated materials is a key element of each task. Experimental studies generally involve small, laboratory specimens whose behavior forms the basis to develop predictive methods for structural assessment. These studies are supported by analytical models of the mechanisms responsible for the observed behavior. The data will provide the basis for codes and standards, test methods, and revisions to NRC Guides.

21703 (NUREG–0975-Vol.6, pp. 173-191) **Surveillance data bases, analysis, and standardization program.** Kam, F.B.K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

Objectives of the program are to: validate and improve methodologies and data bases which are used to predict neutron exposure and radiation embrittlement parameters; prepare and update voluntary consensus standards (or NUREGs) which can be used to support recommendations for data bases and methodologies in codes and regulatory guides relating to the surveillance of light water reactor pressure vessels; and maintain, upgrade, and develop data bases, predictive procedures, and standards relating to reactor pressure vessel fluence spectra determination and embrittlement assessment. Program activities are conducted in the areas of neutron dosimetry and transport calculations, the Embrittlement Data Base and damage correlation studies, and coordination and standardization activities.

21704 (NUREG–0975-Vol.6, pp. 282-291) **Aging studies on materials from the Shippingport reactor.** Shack, W.J. (Argonne National Lab., IL (USA)); Kassner, T.F.; Chopra, O.K.; Chung, H.M.; Maiya, P.S.; Park, J.Y.; Ruther, W.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this program is to develop an understanding of the metallurgical phenomena that may occur in nuclear reactor structural materials as a consequence of extended service at operating temperatures within and outside of the radiation environment and to assess the impact of these phenomena on structural integrity. Aging phenomena such as the embrittlement of cast stainless steel, low-temperature sensitization of austenitic stainless steels, and radiation embrittlement of pressure vessel steels have been studied in the laboratory; consequently, most of the information is based on simulations of actual reactor conditions. The Shippingport reactor offers a unique opportunity to validate and benchmark the laboratory studies, and thereby to provide a sound basis for evaluating the integrity of structural components near the end of the projected life of the plant. The work in the program is currently divided into four tasks: (1) procurement of materials from Shippingport and other operating reactors; (2) study of the aging degradation of cast-duplex stainless steel; (3) irradiation embrittlement and stress corrosion cracking of irradiated components; and (4) exploratory studies to identify the possibility of new, previously unknown mechanisms of component degradation. As opportunities arise, additional materials will be procured from other reactors that may be more prototypical of current LWRs, and the extent of degradation in these materials will be evaluated and compared with results from the Shippingport components.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 21740, 21745, 21777, 21778, 21793, 21801, 22102, 22103, 22183, 22541, 22601

21705 (CEGB-ESTD-L–0015/R89) **Ichthyoplankton entrainment at Wylfa power station, Anglesey and implications for a further siting proposal.** Dempsey, C.H.; Rogers, S.I. Central Electricity Research Labs., Leatherhead (UK). Jul 1989. 15p. Order Number DE90620243. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A 12 month survey of ichthyoplankton in the cooling water system of Wylfa Power Station and the surrounding 40 km^2 of sea, was carried out between October 1986 and September 1987. The larvae of 31 species and the eggs of 8 species were identified in the survey. Samples taken from the cooling water system and by boat from offshore were largely similar in respect of species diversity and density. Estimates of annual losses due to entrainment are given both in terms of immediate losses and consequential losses of adults to the population. Estimates of losses of six commercially exploited species are considered in terms of loss to the commercial fishery. Assuming the 'worst case' of a 100% mortality of eggs and larvae passing through the cooling system, losses of ichthyoplankton due to entrainment at the existing 'magnox' nuclear power station at Wylfa Point are small and could have no significant adverse effect on fish populations of those species entrained. The operation of the proposed 'pressurised water reactor' nuclear power station on the same site would increase losses by up to 100%. Such an increase would still not alter the existing situation. No significant adverse effect is likely. (author).

21706 (CEGB-RD-B–6174/R89) **The effect of oxidation on the integrity of bolted structures.** McLauchlin, I.R. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1989. 19p. (CONF-8903199–: Oxidation and mechanical properties conference, London (UK), 15 Mar 1989). Order Number DE90620135. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Oxide growing on mild and low alloy steel components in the high pressure CO_2 based coolant of the UK gas cooled nuclear

power stations can become porous and continue to grow at the interfaces of structural components even when any interfacial gap has filled with oxide. Because such growth gives rise to a net volume expansion, the adjacent components can be forced apart. Any fastening, such as a weld or bolt, holding them together can then become stressed due to growth of oxide alone, and may sustain mechanical damage. The phenomenon is now well understood and methods of predicting behaviour have been developed and refined over the years to ensure safe and continued plant operation. The basis of such methods is presented for bolted joints, and the way in which joint geometry, environment and mechanical properties of component material influence bolt strain is outlined, with examples. (author)

2104 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated

21707 (IAEA-TECDOC–524, pp. 79-93) **Probabilistic safety assessment goals in Canada.** Snell, V.G. (Atomic Energy of Canada Ltd, Mississauga, Ontario (Canada). CANDU Operations, Risk Assessment and Safety Design Branch). International Atomic Energy Agency, Vienna (Austria). Sep 1989. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic safety criteria, Vienna (Austria), 27-31 Jan 1986). In *Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.* Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

CANDU safety philosophy, both in design and in licensing, has always had a strong bias towards quantitative probabilistically-based goals derived from comparative safety. Formal probabilistic safety assessment began in Canada as a design tool. The influence of this carried over later on into the definition of the deterministic safety guidelines used in CANDU licensing. Design goals were further developed which extended the consequence/frequency spectrum of 'acceptable' events, from the two points defined by the deterministic single/dual failure analysis, to a line passing through lower and higher frequencies. Since these were design tools, a complete risk summation was not necessary, allowing a cutoff at low event frequencies while preserving the identification of the most significant safety-related events. These goals gave a logical framework for making decisions on implementing design changes proposed as a result of the Probabilistic Safety Analysis. Performing this analysis became a regulatory requirement, and the design goals remained the framework under which this was submitted. Recently, there have been initiatives to incorporate more detailed probabilistic safety goals into the regulatory process in Canada. These range from far-reaching safety optimization across society, to initiatives aimed at the nuclear industry only. The effectiveness of the latter is minor at very low and very high event frequencies; at medium frequencies, a justification against expenditures per life saved in other industries should be part of the goal setting. (author). 14 refs, 2 figs, 5 tabs.

2105 Power Reactors, Breeding

Refer also to citation(s) 21455, 21732, 21775, 21795, 21796, 21797, 21845

21708 (ENEA-RT-VEL–85-2) **Notes on sodium technology: Sodium as coolant for fast reactors, Volume 1.** Ferretti, F.; Fogliani, F. ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1985. 26p. (In Italian). Order Number DE89761985. Available from NTIS (US Sales Only), PC A03/MF A01.

These remarks on sodium technology contain basic informations about its operating characteristics when utilized as process fluid in experimental plants. Furthermore, knowledges about chemistry of sodium, safety, maintenance and instrumentations of plants are furnished for a good management of these.

21709 (JAERI-M–89-141) **Revision of fast reactor group constant set JFS-3-J2.** Takano, Hideki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Kaneko, Kunio. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 82p. (In Japanese). Order Number DE90759879. Available from NTIS (US Sales Only), PC A05/MF A01.

To improve the fast reactor group constant set JFS-3-J2 to be applicable for high burnup reactor calculations, group constants for 155 fission product nuclides and the lumped group cross sections for four mother fission isotopes of U-235, U-238, Pu-239 and Pu-241 have been generated. Furthermore, the group constants for higher actinides such as Am and Cm have been produced on the basis of the JENDL-2 nuclear data, so as to be able to use for TRU-transmutation calculations. Benchmark test of this revised set has been performed by analysing the 21 fast critical experimental assemblies. Benchmark calculation system based on one-dimensional Sn-method has been developed to investigate the accuracy of one-dimensional diffusion calculations. Significant difference between the results obtained with the diffusion and transport calculations was observed for small cores and the assemblies with iron or nickel reflector. (author).

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 21736

21710 (JAERI-M–89-158) **Concept design of Advanced Marine Reactor, (2): System design, (1): design study for simplification of system.** Ambo, Noriaki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Itoh, Yasuyoshi; Yokomura, Takeyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 23p. (In Japanese). Order Number DE90759887. Available from NTIS (US Sales Only), PC A03/MF A01.

We started the design study of the concept design of the Advanced Marine Reactor from FY 1987, and we researched and studied as for the optimization of the core and the components of the reactor plant in FY 1987. This report describes as for the system design result until today of the reactor plant that main research thema is minituarization and simplification of system. This integrated type reactor is composed from the helical-coil steam generator, pressurizer and CRDM (control rod drive mechanism) that are installed innerside reactor vessel, and the primary coolant pumps attached on the lid of reactor vessel. As the result, it was possible that plant miniatuarization and removal of possibility for the large or middle-size pipe rupture (large or middle LOCA) and rod ejection accident, and simplization of safety system. As the result of an application of the above integrated type reactor, we are able to construct of the marine reactor plant system that is composed from the simplized safety system composed from only the passive components except some remote control valves. (author).

21711 (JAERI-M–89-159) **Concept design of Advanced Marine Reactor, 3: System design, 2: design study for miniaturization and lighter weight of system.** Ambo, Noriaki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Itoh, Yasuyoshi; Yokomura, Takeyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 70p. (In Japanese). Order Number DE90759886. Available from NTIS (US Sales Only), PC A04/MF A01.

We started the design study of the concept design of the Advanced Marine Reactor from FY 1987, and we researched and studied as for the optimization of the core and the components of the reactor plant in FY 1987. This report describes as for the system design result until today of the 100 MWt reactor plant that main research theme is minituarization and lighter-weight of system. This plant is composed from integrated type reactor installed the primary system components inside of reactor vessel, the wet-type spherical containment vessel that is preserved water in containment vessel and soaks the reactor vessel and the decay heat removal system concerned with the passive concept that is applicated of natural circulation. As the results, it was possible that plant miniaturization and lighter-weight, and simplization and passive concepted components of almost all safety systems. As the result of a application of the above wet-type containment vessel, the blow flow in LOCA is made containment vessel water level higher up and CV inner pressure is higher up, so that the pressure

restrict the blow flowrate and no core be dry without ECCS system. And the shielding weight is able to much light according to the shielding effect of containment vessel water. (author).

21712 (N–90-15030) **SP-100 power system conceptual design for lunar base applications.** Mason, L.S.; Bloomfield, H.S.; Hainley, D.C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 22p. (NASA-TM–102090;E–5083;NAS–1.15:102090;CONF-890103–: 6. symposium on space nuclear power systems, Albuquerque, NM (USA), 9-12 Jan 1989). Available from NTIS, PC A03/MF A01.

A conceptual design is presented for a nuclear power system utilizing an SP-100 reactor and multiple Stirling cycle engines for operation on the lunar surface. Based on the results of this study, it was concluded that this power plant could be a viable option for an evolutionary lunar base. The design concept consists of a 2500 kWt (kilowatt thermal) SP-100 reactor coupled to eight free-piston Stirling engines. Two of the engines are held in reserve to provide conversion system redundancy. The remaining engines operate at 91.7 percent of their rated capacity of 150 kWe. The design power level for this system is 825 kWe. Each engine has a pumped heat-rejection loop connected to a heat pipe radiator. Power system performance, sizing, layout configurations, shielding options, and transmission line characteristics are described. System components and integration options are compared for safety, high performance, low mass, and ease of assembly. The power plant was integrated with a proposed human lunar base concept to ensure mission compatibility. This study should be considered a preliminary investigation; further studies are planned to investigate the effect of different technologies on this baseline design.

2107 Regulation and Licensing

Refer also to citation(s) 21469, 21670, 21689, 21695, 21794, 21795, 21804, 21805, 21806, 21838, 21840, 21844, 21847

21713 (NUREG–0750-Vol.30-Index-1) **Indexes to Nuclear Regulatory Commission issuances, July–September, 1989: Volume 30: Index 1.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Feb 1990. 45p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Appeal Panel (ALAB), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judge (ALJ), the Directors' Decision (DD), and the Denials of Petitions of Rulemaking are presented in this document. These digests and indexes are intended to serve as a guide to the issuances. Information elements common to the cases heart and ruled upon are: case name (owner(s) of facility); full text reference (volume and pagination); issuance number; issues raised by appellants; legal citations (cases, regulations, and statutes); name of facility, docket number; subject matter of issues and/or rulings; type of hearing (for construction permit, operating license, etc.); and type of issuance (memorandum, order, decision, etc.).

21714 (NUREG–1214-Rev.5) **Historical data summary of the Systematic Assessment of Licensee Performance: Revision 5.** Allenspach, F.; Nease, R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Licensee Performance and Quality Evaluation. Feb 1990. 112p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

The Historical Data Summary of the Systematic Assessment of Licensee Performance (SALP) is produced periodically by the US Nuclear Regulatory Commission. This summary provides the results of the assessment for each facility by NRC region and is further divided into the following sections: Section 1 presents the most recent SALP report ratings for facilities in operation and under construction. Section 2 presents a chronological listing of all SALP report ratings for each operating facility. Section 3 presents a chronological listing of all SALP report ratings for each facility under construction. For historical purposes, past construction ratings for facilities that recently have been licensed also are listed in Section 3.

21715 (NUREG/CR–2000-Vol.9-No.1) **Licensee Event Report (LER) compilation for month of January 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data; Oak Ridge National Lab., TN (USA). Feb 1990. 105p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/NSIC–200-Vol.9-No.1). Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

This monthly report contains Licensee Event Report (LER) operational information that was processed into the LER data file of the Nuclear Safety Information Center (NSIC) during the one month period identified on the cover of the document. The LERs, from which this information is derived, are submitted to the Nuclear Regulatory Commission (NRC) by nuclear power plant licensees in accordance with federal regulations. Procedures for LER reporting for revisions to those events occurring prior to 1984 are described in NRC Regulatory Guide 1.16 and NUREG-0161, Instructions for Preparation of Data Entry Sheets for Licensee Event Reports. For those events occurring on and after January 1, 1984, LERs are being submitted in accordance with the revised rule contained in Title 10 Part 50.73 of the Code of Federal Regulations (10 CFR 50.73 — Licensee Event Report System) which was published in the Federal Register (Vol. 48, No. 144) on July 26, 1983. NUREG-1022, Licensee Event Report System — Description of Systems and Guidelines for Reporting, provides supporting guidance and information on the revised LER rule.

21716 (Stralenbescherming–33) **Evaluation of the system of licences and the registration of radioactive materials of the Dutch Nuclear power law: Final report.** Bressers, J.T.A.; Arentsen, M.J.; Kuks, S.M.M.; Landkroon, J.D. Technische Univ. Twente, Enschede (Netherlands). Jun 1988. 78p. (In Dutch). (VROM–80405/11-88). Order Number DE90706054. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

In this report the registration regulation of radioactive materials ex. article 28 of the Dutch Nuclear power law and the system of licenses ex. article 29 and 34 are evaluated and recommendations are made for a revision of the registration regulation and the license systems. 75 refs.

22 NUCLEAR REACTOR TECHNOLOGY

Refer also to citation(s) 21687

2201 Theory and Calculation

Refer also to citation(s) 21732

21717 (CEGB-RD-B–6210/R89) **Derivation of decay heat benchmarks for U235 and Pu239 by a least squares fit to measured data.** Tobias, A. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. May 1989. 46p. (DIDSG-P–(88)388). Order Number DE90620126. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A least squares technique used by previous authors has been applied to an extended set of available decay heat measurements for both U235 and Pu239 to yield simultaneous fits to the corresponding beta, gamma and total decay heat. The analysis takes account of both systematic and statistical uncertainties, including correlations, via calculations which use covariance matrices constructed for the measured data. The results of the analysis are given in the form of beta, gamma and total decay heat estimates following fission pulses and a range of irradiation times in both U235 and Pu239. These decay heat estimates are considered to form a consistent set of benchmarks for use in the assessment of summation calculations. (author).

21718 (CONF-900418–7) **NEACRP standard problem exercise on criticality codes for dissolving fissile oxides in acids: A reference method for treating the fuel double heterogeneity.** Santamarina, A. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Div. d'Etudes et de Developpement des Reacteurs); Smith, H.J.; Whitesides, G.E. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE

Energy Research. DOE Contract AC05-84OR21400. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90008742. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The value of international comparison studies by the OECD-NEA Criticality Working Group has again been demonstrated by this study. Computational methods that had been commonly used for criticality safety calculations and which were shown to be valid for systems for which experimental data existed, were demonstrated to be inadequate when extrapolated to some simulated actual situations. The major source of dispersion in the results in international criticality benchmark calculations on problems treating a fuel double heterogeneity is shown to be the incorrect evaluation of effective resonance cross sections for 238U. A reference calculational method is proposed and used to evaluate theoretically the errors created by various standard methods of calculating the effects of self-shielding of resonance cross sections. 7 figs., 3 tabs.

21719 (JAERI-M–89-175) **Layered model based on GMDH for reactor noise signals.** Hayashi, Koji (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Shinohara, Yoshikuni; Suzuki, Katsuo; Nabeshima, Kunihiko. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 98p. (In Japanese). Order Number DE90759896. Available from NTIS (US Sales Only), PC A05/MF A01.

The layered model based on GMDH (Group Method of Data Handling) has been studied for the modeling of non-linear reactor noise signals. This is the first report on the study which is concerned with the principle and the overview of the GMDH, the layered model and its fitting algorithm and the theoretical and numerical investigations of the linear layered model. The fitting algorithm of the layered model with single-input and single-output is described in detail at each processing step and its expansions to univariate and multivariate layered models with feedbacks are also described. Next, the normal equation which gives the coefficients of a fundamental function of Kolmogorov-Gabor type is considered from the view point of the statistical signal processing. It is found that the estimate of the coefficients consists of high order correlation functions. Furthermore, the relationship between the linear layered model and AR (Autoregressive) model is considered. From the results, it is found that the linear layered model has coefficients equivalent to those of AR model. It is also found that, by assuming white noise sources, the linear layered model as well as the AR model is capable to identify and to decompose the subsystems in a multivariate feedback system. Finally, the linear layered model is tested through numerical fitting calculations using some linear simulation data and is compared with the AR model respect to the coefficients and the prediction errors. (author).

21720 (NUREG–0975-Vol.6, pp. 402-404) **Effectiveness and safety aspects of selected decontamination methods.** Duce, S.W.; Mandler, J.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of the program is to obtain recontamination data at boiling water reactors (BWR) on primary coolant recirculation piping that were either replaced or previously chemically decontaminated. These data are then to be incorporated with recontamination data obtained from prior years and analyzed for trends. FY 1987 work scope included: reviewing literature, establishing a data base, and writing a research plan; identifying, selecting and scheduling utilities to be visited; obtaining and evaluating recontamination data; and preparing project reports.

21721 (PSI–55) **Nucleonic calculations for possible irradiation experiments in SAPHIR.** Caro, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Pelloni, S. Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Jan 1990. 17p. Order Number DE90620127. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Accurate two-dimensional calculations show that a 'neutronic environment' exists in the SAPHIR reactor at the Paul Scherrer Institute (PSI) to simulate the inner surface of a given trepan of the Gundremmingen reactor. Neutron fluences and DPA rates were calculated at two positions in SAPHIR using the modern codes and nuclear data (from JEF-1). A particular region of the reactor can be found in which fluences and DPA rates agree well within a few percent with the Gundremmingen reference case. (author) 13 figs., 4 tabs., 18 refs.

21722 (PSI–56) **Assessment of NJOY generated neutron heating factors based on JEF/EFF-1.** Vontobel, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Jan 1990. 33p. Order Number DE90620128. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using the NJOY nuclear data processing system, a coupled neutron-photon multigroup MATXS-formatted nuclear data library was generated based on the files JEF/EFF-1. The neutron heating factors contained in this VITAMIN-J structured library are compared with those of MACLIB-IV. The main differences are due to the included decay heat of shortlived reaction products in MACKLIB-IV and/or due to too high/low photon production data of some JEF/EFF-1 isotopes. It is recommended to check carefully the energy balance of new evaluations containing photon production data. How this can be done with the help of the NJOY HEATR module is shown in an example. (author) 35 figs., 9 refs.

21723 **Development of advanced nodal diffusion methods for modern computer architectures.** Rajic, H.L. Thesis (Ph. D.). 548p. Univ. of Illinois, Urbana-Champaign, IL (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-08,810.

A family of highly efficient multidimensional multigroup advanced neutron-diffusion nodal methods, ILLICO, were implemented on sequential, vector, and vector-concurrent computers. Three-dimensional realistic benchmark problems can be solved in vectorized mode in less than 0.73 s (33.86 Mflops) on a Cray X-MP/48. Vector-concurrent implementations yield speedups as high as 9.19 on an Alliant FX/8. These results show that the ILLICO method preserves essentially all of its speed advantage over finite-difference methods. A self-consistent higher-order nodal diffusion method was developed and implemented. Nodal methods for global nuclear reactor multigroup diffusion calculations which account explicitly for heterogeneities in the assembly nuclear properties were developed and evaluated. A systematic analysis of the zero-order variable cross section nodal method was conducted. Analyzing the KWU PWR depletion benchmark problem, it is shown that when burnup heterogeneities arise, ordinary nodal methods, which do not explicitly treat the heterogeneities, suffer a significant systematic error that accumulates. A nodal method that treats explicitly the space dependence of diffusion coefficients was developed and implemented. A consistent burnup-correction method for nodal microscopic depletion analysis was developed.

2202 Components and Accessories

Refer also to citation(s) 21708, 21837, 22095, 22133

21724 (CEGB-RD-L–3387/R88) **Simple methods for predicting gas leakage flows through cracks.** Ewing, D.J.F. Central Electricity Research Labs., Leatherhead (UK). Jan 1989. 14p. Order Number DE90620136. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report presents closed-form approximate analytical formulae with which the flow rate out of a through-wall crack can be estimated. The crack is idealised as a rough, tapering, wedgeshaped channel and the fluid is idealised as an isothermal or polytropically-expanding perfect gas. In practice, uncertainties about the wall friction factor dominate over uncertainties caused by the fluid-dynamics simplifications. The formulae take account of crack taper and for outwardly-diverging cracks they predict flows within 12% of mathematically more accurate one-dimensional numerical models. Upper and lower estimates of wall friction are discussed. (author).

21725 (CEGB-RD-M–1789/RR89) **Weld repair issues in thick section austenitic pipework.** Goodwin, S.J.; Price, A.T. Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs. Mar 1989. 31p. Order Number DE90620137. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Thick section austenitic Type 316 Stainless steel, in the solution treated condition, has been used in Central Electricity Generating Board plant in the United Kingdom for some three decades and has given good service. Repair and replacement of this material after long term service is becoming a requirement and is complicated by the precipitation hardening and sensitisation of the materials. This paper summarises the compositional, microstructural and ageing characteristics of the wrought material and weld metals and the consequences for materials properties. Post weld heat treatment options are outlined and sensitisation to stress corrosion cracking is discussed. Finally, some examples of cracking that has occurred in plant after long term operation are given and weld repair research requirements are noted. (author).

21726 (FRNC-TH–3485) **Conception and realization of an expert system to help the interpretation of the mechanical shocks in a nuclear power plant.** Brunet, E. Universite de Technologie de Compiegne, 60 (France). 1988. 322p. (In French). Order Number DE90756432. Available from NTIS (US Sales Only), PC A14/MF A01.

The computer system MIGRE, developed with the aim of helping the understanding of mechanical shocks in the nuclear power plant primary circuit. The MIGRE system allows the description of a study domain, the acquisition and exploitation of operational knowledges. The structural organization of the system is submitted to two constraints: in the first place, the system's operation depends on the accomplishment and development of an application, and on a diagnostic's research; the second constraint is the fact that the work space of PROLOG, on Macintoch, is restricted. A specific configuration is associated to each one of the work environments. The organization principle (in "hierarchical Worlds") of a program by PROLOG, allows to reach easily this kind of architecture. This principle makes a modular organization easy and allows to distinguish statical from dynamical steps of the system. The selection of the system different functions takes place by menus. The transition from one configuration to another is automatically effectuated and unseen by the user. Problems applying the Knowledge acquisition and the wandering bodies function, are also considered.

21727 (VTT-TUTK–598) **Estimation of some stochastic models used in reliability engineering.** Huovinen, T. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Apr 1989. 146p. Order Number DE90620138. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The work aims to study the estimation of some stochastic models used in reliability engineering. In reliability engineering continuous probability distributions have been used as models for the lifetime of technical components. We consider here the following distributions: exponential, 2-mixture exponential, conditional exponential, Weibull, lognormal and gamma. Maximum likelihood method is used to estimate distributions from observed data which may be either complete or censored. We consider models based on homogeneous Poisson processes such as gamma-poisson and lognormal-poisson models for analysis of failure intensity. We study also a beta-binomial model for analysis of failure probability. The estimators of the parameters for three models are estimated by the matching moments method and in the case of gamma-poisson and beta-binomial models also by maximum likelihood method. A great deal of mathematical or statistical problems that arise in reliability engineering can be solved by utilizing point processes. Here we consider the statistical analysis of non-homogeneous Poisson processes to describe the failing phenomena of a set of components with a Weibull intensity function. We use the method of maximum likelihood to estimate the parameters of the Weibull model. A common cause failure can seriously reduce the reliability of a system. We consider a binomial failure rate (BFR) model as an application of the marked point processes for modelling common cause failure in a system. The parameters of the binomial failure rate model are estimated with the maximum likelihood method.

21728 **Lessons in solid-state kinetics from nuclear energy research.** Rothman, S.J. (Argonne National Lab., IL (USA). Materials Science and Technology Div.). *Journal of Metals (USA)*, 41(12): 20-22 (Dec 1989).

The field of research on solid-state kinetics grew enormously, along with the rest of materials research, in the decades following World War II. The author discusses how research on kinetics in the U.S., the United Kingdom, France and the U.S.S.R. is linked to the reactor development program. This is due to material problems in reactors caused by solid-state reactions or diffusion, the availability of reactor-produced radiotracers, and the early realization of the close connections among radiation behavior, point defects and diffusion.

21729 **Nuclear production research expands materials knowledge.** Caskey, G.R. (Savannah River Lab., Aiken, SC (USA)); Rankin, D.T.; Louthan, M.R. Jr. *Journal of Metals (USA)*, 41(12): 15-19 (Dec 1989).

Interrelationships among systems, processes and technologies are frequently obscure, but correlations develop if the history of a technology is reviewed. According to the authors, progress in technology depends on the willingness and ability of the developer or investigator to share ideas, thus promoting interactions with other investigators. They discuss how materials technologies developed during the operation of nuclear production reactors have contributed significantly to other areas. This paper reports on one nuclear facility which has contributed significantly to this expansion of materials knowledge, the Savannah River Site (SRS) in South Carolina.

2203 Fuel Elements

Refer also to citation(s) 21469, 21568, 22095, 22212, 22215

21730 (JAERI-M–89-178) **Reflood experiments in single rod channel under high-pressure condition.** Xu, Guohua (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Kumamaru, Hiroshige; Tasaka, Kanji. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 41p. Order Number DE90759902. Available from NTIS (US Sales Only), PC A03/MF A01.

Reflood experiments were performed in the single rod test facility of Japan Atomic Energy Research Institute (JAERI). The objective of testing was to investigate thermal-hydraulic behavior during reflood. The primary parametric variables were the reflooding flow rate, initial surface temperature and linear power. All the experiments were conducted at 1 MPa. In the experiments, saturated water was injected. The experiments covered reflooding flow rate from 0.01 to 0.18 m/s, initial surface temperature from 677 to 903 K and linear power from 0 to 2.712 kW/m. The axial power profile was uniform. The test results show that the ratio of quench velocity to reflooding flow rate varied from 0.204 to 0.744. There are the effects of thermal parameters on the ratio of quench velocity to reflooding flow rate. The results of high reflooding flow rate tests indicate the presence of a significant quantity of entrained liquid in the steam flow. The fluid thermocouple located at 2m from inlet of heated region was quenched at 8.5 sec after beginning of reflood and the ratio of liquid penetration velocity to quench velocity reaches 6.39, when reflooding flow rate is 0.18 m/s. The quench temperature varies between 633 K (lowest value) and 708 K (highest value). It is limitted in a narrow range, approximately in 75 K. The experiments show the film boiling heat transfer coefficients scatter in a narrow band at the same length L_Q (length from quench front) except for the data measured at low flow rates and low linear powers. (author).

21731 (NUKEM-FuE–88043) **Safety studies on the production of silicide fuel with low uranium enrichment in the framework of the AF programme, project no. 13. Final report.** Koch, K.H.; Wehner, E. Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1989. 13p. (In German). Contract BMFT ATT 9377 2. Order Number DE90759104. Available from NTIS (US Sales Only), PC A03/MF A01.

The final report on project No. 13 of the program for the reduction of enrichment in research reactors (AF program) provides information on safety tests for the production of silicide fuels of low enrichment (LEU). The project was terminated in advance, owing to the temporary suspension of the legal approval of the nuclear chemicals and metallurgical company NUKEM under atomic energy law, and to the final decision to stop the production of MTR fuel

elements by that company. For this reason, the tests only led to interim results. Starting from these partial results obtained in the tests, further development prospects are illustrated for uranium silicide manufacture, fuel comminution, powder treatment in inert gas boxes, and the rationalization of the manufacture of fuel plates and fuel elements. (orig./HP).

2204 Control Systems

Refer also to citation(s) 21447, 21569, 21693, 21697, 21703, 21803, 22095, 22549

21732 (CONF-900418–6) **A benchmark for investigating the radial dependence of C/E for control rod worths in large decoupled cores.** Salvatores, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France)); Orechwa, Y.; Collins, P.J. Argonne National Lab., IL (USA). [1990]. 36p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90007798. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The first physics measurements of a heterogeneous core on the critical assembly ZPPR-7 at ANL showed that the C/E ratios with ENDF/B data for the worths of the control rods in the outer bank were several percent higher than those at the inner bank positions. This radial variation in the C/E for the rod worths was further confirmed in the analysis of the large conventional core ZPPR-10, and again in the analysis of the large heterogeneous core series ZPPR-13. In the design of a power reactor, the number of control rods, and their disposition, are determined by calculations. Misprediction of the worth of the control rods can lead to serious economic penalties by restricting the operation of the core. Retrofitting a core to accommodate more worth will be costly and is likely to lead to a non-optimized core. This document provides a discussion of these calculations. 7 refs., 7 figs., 12 tabs.

21733 (CONF-900597–1) **Using formal methods to develop a paradigm for software design.** Chisholm, G.H. (Argonne National Lab., IL (USA)); Smith, B.T.; Wojcik, A.S. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International workshop on formal methods in software development; Napa, CA (USA); 9-11 May 1990. Order Number DE90005633. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Formal methods have been used to analyze the properties of many kinds of systems. Over the past several years, a group at Argonne National Laboratory has been investigating the use of formal analysis techniques to study the behavior of fault tolerance in reactor control systems. This investigation has revealed that the key issue in modeling and qualifying fault tolerance properties is independence. Traditional verification tools (including formal analysis) deal with the issue of independence implicitly. For example, fault-injection testing may discover an instance where independence is not maintained when a system crash results from the injection of a single fault. However, this discovery is an effect of the method, in contrast to being a behavior for which the analysis is explicit. In contrast, the approach we describe here is based on the determination of essential system properties and the development of an analysis strategy that facilitates a formalization of that property within the context of the design. 9 refs.

21734 (CONF-9004138–1) **Development of a robust model-based reactivity control system.** Rovere, L.A. (Tennessee Univ., Knoxville, TN (USA)); Otaduy, P.J.; Brittain, C.R. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From 3. international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990. Order Number DE90007655. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the development and implementation of a digital model-based reactivity control system that incorporates a knowledge of the plant physics into the control algorithm to improve system performance. This controller is composed of a model-based module and modified proportional-integral-derivative (PID) module. The model-based module has an estimation component to synthesize unmeasurable process variables that are necessary for the control action computation. These estimated variables, besides being used within the control algorithm, will be used for diagnostic purposes by a supervisory control system under development. The PID module compensates for inaccuracies in model coefficients by supplementing the model-based output with a correction term that eliminates any demand tracking or steady state errors. This control algorithm has been applied to develop controllers for a simulation of liquid metal reactors in a multimodular plant. It has shown its capability to track demands in neutron power much more accurately than conventional controllers, reducing overshoots to almost negligible value while providing a good degree of robustness to unmodeled dynamics. 10 refs., 4 figs.

21735 (EUR-FC–1358) **A new protection system against high voltage vacuum breakdowns developed for the Tore Supra neutral beam injector prototype.** Fumelli, M.; Jequier, F.; Pamela, J. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1988. 25p. Available from NTIS (US Sales Only), PC A03/MF A01.

A passive protection system against high voltage vacuum breakdowns has been developed. This system is based on the principle of oscillatory discharges in an RLC circuit coupled with the use of a diode. It allows the interruption of a vacuum breakdown in a few milliseconds. This study has been made for protecting some parts of the neutral beam injectors of the Tore Supra Tokamak experiment, but its field of application should be quite large. The conception of the whole high voltage electrical circuit developed for the Tore Supra injector prototype experiments is also presented.

21736 (JAERI-M–89-174) **A feasibility study on the innovative control rod driving mechanism, (1).** Ishizaka, Yuichi; Itoh, Yasuyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 115p. (In Japanese). Order Number DE90759925. Available from NTIS (US Sales Only), PC A06/MF A01.

The objectives of this study are to establish innovative Control Rod Driving Mechanisms (CRDMs) in order to achieve a highly safe and economic Advanced Marine Reactor (Ship). The innovative CRDMs to be carried this ship with Advanced Marine Reactor are to be installed in the reactor pressure vessel, since the internal CRDMs can eliminate 'Control Rod Ejection' which had been one of the design bases accidents on the licensing issues for conventional LWR with external CRDMs. This report presents the following works. After the discussion of the design requirement on the innovative CRDMs which had been selected as 'Concept Design of Advanced Marine Reactor (1), System Design (1), Design Study for Simplification of System', the scheme of the selected concept were considered and set up tentatively. Subsequently the development plan of the innovative CRDMs was made out. The major assets required for the internal CRDMs were heat-resistance and insulation-resistance of those electro-parts. The concept on the following key parts of the innovative CRDMs' electro-parts were embodied. Built-in-Motor, Scram-Magnet. Based on the concept, some kinds of typical heat-resistance wires estimated to be eligible used in the reactor pressure vessel were nominated. After the basic characteristics test screened out them to be a few, the heat-resistance wire eligible for the internal CRDMs' electro-parts were specified by the trial manufacturing and performance test of miniature coils made of selected wires. (author).

21737 (JAERI-M–89-183) **A study on continuous monitering and self-started diagnosis with signal validation using DISKET.** Yoshida, Kazuo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 16p. (In Japanese). Order Number DE90759901. Available from NTIS (US Sales Only), PC A03/MF A01.

One of key issues in the application of expert system technology for transient diagnosis to real nuclear power plant is continuous monitering and self-started diagnosis with signal validation. A method to realize this function has been proposed and verified using DISKET system developed by JAERI. A simulation system for on-line diagnosis has first been built on the main frame computer at JAERI. The function to moniter plant status continuously and to

start a transient diagnosis triggered by the early fault detection was realized in DISKET using rule representation. The signal validation function was also implemented as the rules which represent the normal relationship between main plant parameters and alarms. The diagnosis of some tipical transients with these rules has been performed for the verification study. In this results, these functions were successfully demonstrated. (author).

21738 (NUREG–0975-Vol.6, pp. 193-209) **Dosimetry measurement reference data base for LWR pressure vessel irradiation surveillance.** McGarry, E.D.; Grundl, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

Objectives of this program are to provide calibration of light water reactor pressure vessel (LWR-PV) related surveillance dosimetry traceable to National Bureau of Standards (NBS) standard neutron fields, including distribution of neutron fluence standards; maintain a compendium of reference data for LWR-PV related benchmark neutron fields; participate in the preparation of ASTM standards for routine LWR-PV dosimetry and in establishing consensus methods of data interpretation; and provide experimental assistance for LWR-PV dosimetry benchmark measurement programs.

21739 **Chemometrics/on-line measurements.** O'Rourke, P.E. (Savannah River Lab., Aiken, SC (USA)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 85-94 (Nov 1989).

The possible future of on-line analytical-quality measurements for improved process control and more timely safeguards measurements is examined in the light of a current project at Savannah River. A measurement system involving a fiber-optic spectrophotometer and the application of mathematical techniques called chemometrics is described.

2205 Environmental Aspects

Refer also to citation(s) 21785, 21791, 21793, 22544, 22584

21740 (CEGB-RD-B–6173/R89) **Measurements of the radioactive inventory of the old effluent pipe line on the BNL site.** Hewison, R.C. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1989. 32p. Order Number DE90619680. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

When Berkeley Nuclear Laboratory (BNL) was built, a 3 inch cast iron pipe was laid to carry the radioactive effluent from the BNL effluent treatment plant to the power station for further treatment and/or discharge. In 1980/81 a new pipe line was installed and since then the old line has remained unused. As part of the refurbishment of certain parts of the BNL site currently in progress, the majority of the pipe is to be dug up in two stages, although a small length of the pipe which runs under existing foundations will be left in the ground. This report gives the radioactive inventory of the pipe based on measurements made during the first state of removal. Samples from the trench dug to expose the pipe were taken before and after the removal of the pipe and analysed to determine whether the pipe had leaked and the level of contamination caused by the pipe's removal. (author).

21741 (EPRI-NP–6668-Vol.2) **STARRS-MMS [Secondary-Side Transport And Retention of Radioactive Species-Modular Modeling System] code: Evaluating steam generator tube ruptures: Volume 2: Programmer's manual, Final report.** Ghaaisiaan, S.M. (Science Applications International Corp., Torrance, CA (USA)); Wassel, A.T. Electric Power Research Inst., Palo Alto, CA (USA); Science Applications International Corp., Torrance, CA (USA). c Feb 1990. 37p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Secondary-Side Transport And Retention of Radioactive Species (STARRS) is a computer code which simulates the thermal-hydraulics and transport of radioactive species in a U-tube steam generator during a tube rupture event. The code consists of separate modules for the analysis of the thermal-hydraulics and the transport of radioactive species in the secondary side. The module of dealing with the transport of radioactive materials is based on models for the transport of volatile and dissolved trace species in the secondary side. It consists of FORTRAN subroutines and can be used as a stand-alone code. It can also be coupled to other thermal-hydraulic codes for performing a transient analysis. The modules dealing with the primary and secondary sides thermal-hydraulics are based on mathematical models compatible with the Modular Modeling System (MMS). The transient conservation equations in these models constitute a system of coupled ordinary differential equations (ODE's). These ODE's are integrated in time, numerically utilizing simulation languages such as EASY5. This simulation language also provides modularity, making it possible for the user of the computer code to build his model using a library of modules. 5 refs., 3 figs., 2 tabs.

21742 (EPRI-NP–6668-Vol.3) **STARRS-MMS [Secondary side Transport And Retention of Radioactive Species-modular modeling system] code: Evaluating steam generator tube ruptures: Volume 3, Users manual, Final report.** Ghaaisiaan, S.M. (Science Applications International Corp., Torrance, CA (USA)); Wassel, A.T. Electric Power Research Inst., Palo Alto, CA (USA); Science Applications International Corp., Torrance, CA (USA). c Feb 1990. 94p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A computer code, STARRS (Secondary side Transport And Retention of Radioactive Species) was developed to predict the thermal-hydraulics of and retention radionuclides in a U-tube steam generator during tube rupture events. The mathematic formulation of the code is described in Volume 1. The code structure modules and FORTRAN subroutines are discussed in Volume 2. The purposes of this document Volume 3, are to describe the code input and output, explain how to use the code. Following the Introduction, a brief description of the theory is given in Section 2. The theory covers the modeling of the UT thermal hydraulics as well as the transport and deposition of the radioactive species in the UT secondary side. The code contains a library of modules, which are written using the Engineering Analysis System 5 (EASY5) simulation language. Each module represents a component model and is fully self-contained. Hence, each module can be exercised as a stand-alone program, depending on the simulation scope. The input requirement and output interpretation are described in Section 3. The input data required for each module, in general, includes parameters, such as length and area, boundary conditions, such as inlet flow and enthalpy, and initial conditions for each state variable. 21 refs., 4 figs., 2 tabs.

21743 (STUK-A–79) **Monitoring of radioactivity in the environs of Finnish nuclear power stations in 1987: Supplement 5 to annual report STUK-A-74.** Sjoeblom, K.-L.; Klemola, S.; Ilus, E.; Arvela, H.; Blomqvist, L. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Jun 1989. 78p. Order Number DE90619480. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Results of the environmental programmes for monitoring radioactive contamination around Finnish nuclear power plants in 1987 are reported. Fallout from the Chernobyl accident, which took place in April 1986, was still dominating the artificial radiation situation in Finland. Thus, large amounts of ^{137}Cs and other long-lived fallout nuclides predominated in the environmental samples taken in the vicinity of nuclear power plants. The extremely small airborne releases from Finnish nuclear power plants were almost totally covered by fallout nuclides. The somewhat higher aquatic releases were easier to distinguish, and it was possible to follow their spread in the marine environment. The contribution of locally discharged nuclides to radiation doses of the population was insignificant.

21744 (VROM–90063/2-89) **Annual report of the Committee for the environment-effect-reporting for the year 1988.** Ministery VROM-Ministery Landbouw en Visserij-Commissie MER Collaboration. Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Hague (Netherlands). 6 Jan 1989. 129p. (In Dutch). Order Number DE90706057. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Includes list of recommendations and reports published at the Committee for the environment-effect-reporting.

This annual report over 1988 presents a general survey of the activities of the Dutch Committee for the environment-effect- reporting (m.e.r). Besides two themes are discussed in depth: the significance of m.e.r. in the decision-making and the discharging from the m.e.r. duty. The appendices contain an overview of the assembly of the Committee, of the gaps in knowledge and information observed in environment-effect reports, the durations of the projects, descriptions of the state of affairs per project and a list of advises brought out by the Committee.

21745 (VTT-TIED–847) **Probabilistic trajectory and dose analysis for Finland due to hypothetical radioactive releases at Sosnovyy Bor.** Nordlund, G. (Finnish Meteorological Inst., Helsinki (Finland)); Valkama, I.; Rossi, J.; Vuori, S. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Mar 1988. 46p. Order Number DE90619688. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Chernobyl accident initiated a wide international interest in developing long range transport models for assessment of radiological consequences due to airborne releases. The Finnish TRADOS computer model had been developed to calculate long range atmospheric dispersion and resulting doses via several exposure pathways. During and after the Chernobyl release the code was utilized to make an initial estimate of the release magnitude and to predict both individual and collective doses in Finland. These calculations proved that the TRADOS system is also well applicable in the acute phase of an accident. In the present study the analysis of atmospheric dispersion to Finland from Sosnovyy Bor near Leningrad and the pertinent dose predictions due to a reactor accident in this area have been made. Both the Chernobyl type release and a smaller release typical of a modern light water reactor at the RBMK-1000 power plant site are considered. The results are compared with the previous studies, in which a smaller release from a light water reactor accident had been assumed to take place in northern Germany and in eastern Sweden (Forsmark). According to the analysis of the number of annual trajectories arriving to Finland from Leningrad this number is with a factor of two less than that for a site in eastern Sweden. Taking this fact into account the radiological risks to Finland seem to be approximately equal when the same release is assumed to have occurred either in Leningrad or in eastern Sweden. Acute health effects in Finland are not caused in either case.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 21721, 21731, 21789, 21826

21746 (ANL/RERTR/TM–9, pp. 22-30) **The German AF-Program status and final activities.** Thamm, G. (Kernforschungsanlage Juelich GmbH (Germany, F.R.)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The German AF-Program (reduced enrichment in research reactors) was officially launched by the Federal Government in November 1979 as a corporate project involving industry and large national research laboratories. It is to be understood primarily as a constructive contribution with in the scope of worldwide efforts at reducing the risk of an uncontrolled proliferation of weapon-usable highly enriched uranium fuels. The program has been adapted to development progress in 1983 and most recently in fall 1986. The last adaptation led to an extension of the program period until the end of 1989. The program priorities comprising the development of high-density uranium fuels, the qualification of fuels under irradiation, the development and establishment of fuel fabrication technologies for low-enrichment uranium (LEU) as well as investigations and planning concerning the conversion of German research reactors from HEU to LEU will be briefly described.

21747 (ANL/RERTR/TM–9, pp. 45-53) **Phase in U-Si alloys.** Domagala, R.F. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The binary (two-component) U-Si systems contains a total of seven compounds. The most U-rich compounds are of interest to the RERTR community because they are now being employed as fuels in research and test reactors. The nomenclature used in describing these fuels and the metallurgical significance of the notations recorded may have different meanings to people from different technical backgrounds. This paper is a succinct exploration of the principles of phase equilibria and the realities of commercial fabrication as applied to U-Si alloys. It is an attempt to record in referenceable and retrievable form information of value to the continued development, application and understanding of silicide fuels.

21748 (ANL/RERTR/TM–9, pp. 54-63) **A study of the effect of fabrication variables on the quality of fuel plates.** Wiencek, T.C. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The control of the quality of dispersion-type fuel plates fabricated for research and test reactors is an issue of concern to plate fabricators. Two variables, void content and number of fuel particles out of zone, were studied by examining the data for various geometries of fuel plates fabricated at ANL. It was found that the porosity of a fuel plate can be increased by (1) decreasing the fuel particle size, (2) increasing the fuel particle surface roughness, (3) increasing the matrix strength, (4) decreasing the rolling temperature, (5) decreasing the final fuel zone thickness, and (6) increasing the volume percentage of the fuel. Porosity formation is controlled by bulk movement and deformation and/or fracture of particles. The most important factor is the flow stress of the matrix material. Lowering the flow stress will decrease the plate porosity. The percentage of plates with fuel-out-of-zone is a function of the fuel material and the loading. The highest percentage of plates with fuel-out-of-zone was observed for U_3Si_2, which is now the most commonly used silicide fuel.

21749 (ANL/RERTR/TM–9, pp. 80-115) **LEU silicide programs at Babcock and Wilcox.** Garner, G.L. (Research and Test Reactor Fuel Element Facility, Lynchburg, VA (USA)); Bogacik, K.E.; Oswood, J.W. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The low enriched silicide development project at Babcock and Wilcox has matured into a production operation that has resulted in the completion of fuel elements for three research reactors; ORR, R-2 Studsvik and SAPHIR. Characteristic anomalies of silicide fuel which make the fabrication of fuel plates and elements more difficult than UAl_x, have either been avoided, eliminated or significantly improved. One such anomaly is the reaction between uranium silicide fuel and aluminum matrix material. A detailed analysis was performed to characterize the extent of this reaction. Data suggests that a solid state diffusion of aluminum atoms into the uranium silicide lattice results in the formation of several intermediate Al-Si-U phases before forming a stable UAl_4 phase.

21750 (ANL/RERTR/TM–9, pp. 116-119) **MEU and LEU fuel elements - Nukem's future policy.** Hassel, H.W. (Nukem GmbH, Hanau (Germany, F.R.)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Since the high density fuels UAl_x (up to 2.2 g U/cc), U_3O_8 (up to 3.2 g U/cc), U_3Si_2 (up to 5 g U/cc) are commercially available and the U_xSi_y (up to 7 g U/cc) is developed, efforts have to be made to minimize the costs for fabrication and inspection. This is the main

goal NUKEM is following up within the next 2 to 3 years by making use of large fabrication batches in the uranium chemistry and fuel element workshops.

21751 (ANL/RERTR/TM–9, pp. 120-131) **MTR fuel development at CERCA status as of October 1986.** Fanjas, Y. (CERCA, Romans (France)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Evolution of fabrication technology at CERCA is reported. Then, the status of CERCA irradiation program is examined. The irradiation program of reduced enriched fuel elements fabricated by CERCA for research reactors is progressing as expected. The in core behavior of the various fuels tested so far is very satisfactory. The paper insists on silicides which will be of major importance for conversion of research reactors to the use of 19.75% enriched uranium.

21752 (ANL/RERTR/TM–9, pp. 142-158) **Quality assurance and inspection techniques in use at Babcock and Wilcox.** Anderson, W.H. Jr. (Babcock and Wilcox, Lynchburg, VA (USA)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

When Babcock and Wilcox reentered the aluminum research reactor fuel element business, most of the equipment, processes and techniques were provided by our customers. Some of the equipment, both manufacturing and inspection, has been in use since the beginning of the program and dates back some 20 years. Babcock and Wilcox has applied the expertise and technology gained from our naval fuel program in several areas of research, fabrication and inspection to update this equipment. Areas of improvement are capacitance non-contact gaging, min-clad gage evaluation and the future of real time x-ray systems. With production and inspection costs rising, Babcock and Wilcox has also initiated alternative possibilities for inspecting components at lower costs and increased precision.

21753 (ANL/RERTR/TM–9, pp. 159-172) **Standardization of specifications and inspection procedures for low-enrichment uranium (LEU) plate-type research reactor fuels.** Krull, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht (Germany, F.R.)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The subject of standardization of specifications and inspection procedures has become important as one means of limiting fuel cost increases inherent with conversions to LEU plate-type research reactor fuels. An edited version of a draft report of an IAEA Consultant's Group is presented here. It is concluded that specifications should be carefully reviewed when changing from HEU to LEU fuel in order to avoid perpetuating overly restrictive requirements. Tentative recommendations are given for a number of specification topics.

21754 (ANL/RERTR/TM–9, pp. 185-200) **Post-irradiation examination of low-enrichment uranium (LEU) miniplates in the JMTR.** Sakai, Haruyuki (Japan Atomic Energy Research Institute, Ibaraki-ken (Japan)); Iwai, Takashi; Sakakura, Atsushi; Saito, Minoru; Oyamada, Rokuro; Yamamoto, Akira; Okamoto, Yoshizo. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Three types of silicide low-enrichment uranium (LEU) miniplates, U_3Si_2 fuel with 4.8 gU/cm^3 and 5.3 gU/cm^3 and U_3Si fuel with 5.3 gU/cm^3, were irradiated in JMTR. The burnups attained by two cycles (44 days) irradiation were 0.58 $\approx$ 0.79 $\times$ 10^{21} fission/cm^3 (25% $\approx$ 38% of initial ^{235}U). Post-irradiation examinations (PIEs) of these miniplates were performed to examine the corrosion, burnup distribution, change of dimensions and weight, blister threshold temperature and metallurgical characteristics. The PIEs showed satisfactory results.

21755 (ANL/RERTR/TM–9, pp. 201-210) **The effect of fabrication variables on the irradiation performance of uranium silicide dispersion fuel plates.** Hofman, G.L.; Neimark, L.A.; Olquin, F.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The effect of fabrication variables on the irradiation behavior of uranium silicide-aluminum dispersion fuel plates is examined. The presence of minor amounts of metallic uranium-silicon was found to have no detrimental effect, so that extensive annealing to remove this phase appears unnecessary. Uniform fuel dispersant loading, low temperature during plate rolling, and cold-worked metallurgical condition of the fuel plates all result in a higher burnup threshold for breakaway swelling in highly loaded U_3Si fuel plates.

21756 (ANL/RERTR/TM–9, pp. 211-221) **Examination of U_3Si_2-Al fuel elements from the Oak Ridge Research Reactor.** Copeland, G.L. (Oak Ridge National Lab., TN (USA)); Hofman, G.L.; Snelgrove, J.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The results of post-irradiation examination of low-enriched U_3Si_2 fuel elements from the Oak Ridge Research Reactor are presented. The elements replaced standard highly-enriched elements and were handled routinely except that the burnup of three of the elements was extended beyond normal limits, up to about 98% peak. The elements were manufactured by commercial fuel suppliers. The performance of all elements was completely satisfactory.

21757 (ANL/RERTR/TM–9, pp. 222-230) **Irradiation and nuclear characteristics measurements of JRR-4 LEU fuel elements.** Morozumi, Minoru (Japan Atomic Energy Research Institute, Ibaraki-ken (Japan)); Kaieda, Keisuke; Arigane, Kenji; Shitomi, Kajimu. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The current status of the examination of JRR-4 LEU experimental fuel elements is reported. UAl_x-Al fuel with a uranium density of 2.2 g/cm^3 was adopted as a candidate for LEU fuel used in the JRR-4. Two LEU experimental fuel elements were fabricated for confirmation of the neutronic performance and for the irradiation test which provides the integrity of the fuel for governmental safety review. One fuel element was irradiated in the JRR-2 core for accelerating burn-up. The irradiation had finished with no trouble until average burn-up reached 42% depletion, and no abnormalities were observed by visual inspection and wet-sipping test. Post irradiation examinations are being progressed and will be finished in 1987. The other elements was loaded in the JRR-4 core, and measurements of reactivity worth and thermal neutron flux distribution were carried out. It was confirmed that the neutronic performance of the LEU fuel met considerably our expected goal.

21758 (ANL/RERTR/TM–9, pp. 231-237) **Progress report on LEU fuel testing in CEA reactors.** Baas, C.; Barnier, M.; Beylot, J.P.; Martel, P.; Merchie, F. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and*

test reactors: Proceedings. Order Number DE88012713. Available from NTIS, PC A23.

The progress achieved in the qualification program of low-enriched fuels in the SILOE reactor is presented in this report. This program, which was begun in 1982, mainly involves irradiation of U_3Si and U_3Si_2 plates and complete elements with respective loadings of 6 g/cm^3 and 5.2 g/cm^3. Periodical examinations were carried out during irradiation, in particular plate thickness and water channel width measurements. Finally, the characteristics of a mixed U_3Si-U_3Si_2 element, irradiation of which is soon to begin in the OSIRIS reactor, are presented.

21759 (ANL/RERTR/TM–9, pp. 238-246) **RERTR program fuel development and testing - the past year and the next.** Snelgrove, J.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Testing and demonstration of reduced-enrichment fuels under the US RERTR Program progressed steadily during the past year. The irradiation and examination of highly loaded miniature fuel plates continued in order to establish performance limits and to search for a more fundamental understanding of the swelling mechanism in aluminum-matrix dispersion fuels. Postirradiation examinations of the full-sized elements irradiated in the ORR have been completed, and the whole-core demonstration of U_3Si_2 fuel elements in the ORR reactor is well underway. The current status of the fuel development and testing effort, the significant results obtained during the past year, and the plans for next year are summarized.

21760 (ANL/RERTR/TM–9, pp. 247-258) **Fabrication and irradiation testing of reduced enrichment fuels for Canadian research reactors.** Sears, D.F. (Atomic Energy of Canada Limited - Research Co., Chalk River, Ontario (Canada)); Berthiaume, L.C.; Herbert, L.N. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The status of the Canadian program to develop and test fuels containing low enriched uranium (LEU) for use in research and test reactors is reviewed. Considerable progress in the manufacturing and testing of the LEU silicide dispersion fuel has been made in 1986. Acquisition and development of large-scale equipment for manufacturing LEU fuels in temporary facilities is near completion and commissioning activities are underway. In the irradiation testing program full-length 12-element dispersed silicide fuel assemblies have been irradiated successfully to burnup levels beyond the design terminal burnup of 80 at% in the NRU reactor without incident. Post-irradiation examinations confirmed the excellent behavior and the similar performance of the Al-USi*Al and the Al-U_3Si dispersions tested. It appears, however, that the U_3Si has marginally better high-burnup performance. Irradiations of mini-elements containing a variety of deliberately-included surface defects and fine silicide particle size distributions, to evaluate whether the limits used in manufacturing specifications could be relaxed, are continuing to show satisfactory performance. Swelling was found to be less than 1 vol% per 10 at% burnup at the fissile loadings of 3.15 MgU/m^3 required for the reactors at CRNL.

21761 (ANL/RERTR/TM–9, pp. 269-286) **The transition phase of the whole-core demonstration at the Oak Ridge Research Reactor.** Hobbs, R.W. (Oak Ridge National Lab., TN (USA)); Bretscher, M.M.; Cornella, R.J.; Snelgrove, J.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The transition from operation of the Oak Ridge Research Reactor with high-enrichment uranium (HEU) fuel to operation with low-enrichment uranium (LEU) fuel is nearing completion. The systematics of the replacement of the HEU fuel with the LEU fuel are discussed. The results of the core physics measurements that have been conducted during the transition phase are described.

21762 (ANL/RERTR/TM–9, pp. 302-309) **Comparison of calculated and measured irradiated wire data for high-enrichment uranium (HEU) and mixed HEU/LEU cores in the ORR.** Hobbs, R.W. (Oak Ridge National Lab., TN (USA)); Cornella, R.J.; Bretscher, M.M. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Low power wire activations are being performed in the Oak Ridge Research Reactor as part of the whole-core low-enrichment uranium demonstration experiments. Calculations of the demonstration cores, including simulation of the wire activations, are being performed at Argonne National Laboratory. This paper presents the results of comparisons for 293 wires from five cores and shows that, on the average, the integrated activities agree within 6%.

21763 (ANL/RERTR/TM–9, pp. 310-319) **Fuel core moderate enrichment uranium (MEU) fuel demonstration in the JMTR.** Saito, Minoru (Japan Atomic Energy Research Institute, Ibaraki-ken (Japan)); Nagaoka, Yoshiharu; Shimakawa, Satoshi; Nakayama, Fusao; Oyamada, Rokuro; Okamoto, Yoshizo. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The joint ANL-JAERI program for the RERTR was started in January 1980. The final goal of this program is to achieve the full core conversion to low-enrichment uranium (LEU) in the JMTR. In 1980, the LEU fuel with silicide had not been qualified yet. In this situation, the moderate-enrichment uranium (MEU) fuel was selected for the first stage, and integrity of the MEU fuel was confirmed through the following three steps: hydraulic test; critical experiments in the JMTRC (Japan Materials Testing Reactor Critical Facility); irradiation test in the JMTR. In August 1986, the full core MEU fuel demonstration test had been successfully completed.

21764 (ANL/RERTR/TM–9, pp. 320-331) **Study on temperature coefficient of reactivity in JUCA light-water moderated and reflected core effect of moderate/fuel ratio and core shape on this quantity.** Kanda, Keiji (Kyoto Univ., Osaka (Japan)); Shiroya, Seiji; Mori, Masaaki; Shibata, Toshikazu. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Both the experimental and analytical studies have been performed on the temperature coefficient of reactivity in the KUCA light-water moderated and reflected core loaded with HEU fuel. The temperature effect on reactivity was measured for the range from 20°C through 70°C to investigated separately the effects of the moderator/fuel ratio and the core shape on this quantity. The results of both the eigenvalue and perturbation calculations by the SRAC code system approximately reproduced the experimental data. It was found that the contribution of the core region was negative to the temperature coefficient due to the degradation of moderation, whereas that of the reflector region was positive due to the decrease in neutron absorption. The positive contribution of the reflector region became larger as the M/F ratio became smaller and the core shape became more slender.

21765 (ANL/RERTR/TM–9, pp. 345-358) **Preliminary low-enrichment uranium (LEU) fuel cycle analyses for the Belgian BR2 reactor.** Deen, J.R.; Snelgrove, J.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Fuel cycle calculations have been performed with reference high-enrichment uranium (HEU) fuel and low-enrichment uranium (LEU) fuel using Cd wires or boron as burnable absorbers. The ^{235}U content in the LEU element has increased 20% to 480g compared to the reference HEU element. The number of fuel plates has remained unchanged while the fuel meat thickness has increased to 0.76 mm from 0.51 mm. The LEU meat density is 5.1 Mg U/m^3. The reference fuel cycle was a 31 element core operating at 56 MW with a 19.8 day cycle length and eight fresh elements loaded per cycle. Comparable fuel cycle characteristics can be achieved using the proposed LEU fuel element with either Cd wires or boron burnable absorbers. The neutron flux for $E_n > 1$ eV changes very little (< 5%) in LEU relative to HEU cores. Thermal flux reductions are 5 to 10% in non-fueled positions, and 20 to 30% in fuel elements.

21766 (ANL/RERTR/TM–9, pp. 359-369) **Selection of fuel type and core pattern and application for low-enrichment uranium (LEU)-licensing of the Danish reactor DR 3.** Haack, K. (Riso National Lab., Roskilde (Denmark)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The preparations on conversion of the Danish research reactor DR 3 to LEU-fuel in 1988 are comprising: (1) Evaluation of the future LEU operation conditions and the expected economical basis for the best possible fulfilling of the requirements of the reactor users. (2) Development and testing of U_3Si_2 LEU fuel elements with 180g ^{235}U. (3) Preparation of the amendments to the safety documentation and application to the authorities on conversion to LEU fuel. Item (1) and (3) is finished, item (2) is in progress with three prototype test elements in the reactor. The approval from the authorities is expected in 1987.

21767 (ANL/RERTR/TM–9, pp. 380-391) **Refueling the RPI reactor facility with SPERT(F-1) fuel rods.** Harris, D.R. (Rennselaer Polytechnic Institute, Troy, NY (USA)); Coleman, M.A.; Rodriguez-Vera, F.; Angelo, P.L.; Birks, D.M.; Yoon, J.; Wicks, F.E. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The RPI Reactor Critical Facility (RCF) has operated for many years with a reactor fueled by highly enriched fuel plates. A program is underway to upgrade the RCF by refueling with 4.81 w/o enriched SPERT(F-1) fuel rods. These fuel rods will permit carrying out useful critical experiments in support of power reactor development and will provide a more meaningful educational experience for RPI students. Use of the already existing SPERT (F-1) fuel rods will result in a considerable cost saving relative to manufacturing new low-enrichment fuel plates. A previous paper emphasized the background and certain structural aspects of the refueling. The present work updates these aspects but emphasizes nuclear and regulatory aspects of the program.

21768 (ANL/RERTR/TM–9, pp. 410-421) **Neutronic scoping calculations for OSURR core design with standardized U_3Si_2 fuel plates.** Seshadri, M.D. (Ohio State Univ., Columbus (USA)); Aldemir, T. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Standardized LEU U_3Si_2 plates will be used in the conversion/upgrade of The Ohio State University Research Reactor (OSURR). Maintaining the present core configuration with standard elements containing 18 standardized fuel plates leads to a large reactivity ($\Delta k/k$). A parametric study is performed to identify the possible first core configurations for the conversion/upgrade of OSURR with 16 plate elements. The variation of excess reactivity; temperature and xenon feedback; and power and flux distributions, is investigated as a function of core configuration. It is estimated that an excess reactivity of 2.5% will be required to operate the LEU OSURR core at 500 kW. Achieving such a $\Delta k/k$ excess necessitates removing the present graphite reflector blocks and going to a 17-18 standard element configuration instead of the present 20 standard element configuration. The final choice will depend on the rod worths for the promising configurations to maintain a 1% cold, clean shutdown margin with the highest worth rod completely withdrawn.

21769 (ANL/RERTR/TM–9, pp. 422-432) **Status of the design of the Munich compact core with involute-shaped fuel plates.** Boening, K. (Technische Universitaet Muenchen, Garching (Germany, F.R.)); Glaeser, W.; Meir, J.; Rau, G.; Roehrmoser, A.; Zhang, L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The cylindrical compact core to be designed for the new research reactor FRM at Munich will presumably have involute shaped fuel plates. It is cooled by light water and surrounded by a large heavy water moderator tank. Its axially movable central beryllium reflector is coated on its lower half with a layer of hafnium absorber. In this paper results are also given for some other reflector materials and for varying the core size. A first optimization yields a compact core of 22 cm diameter and 70 cm active height in which the uranium density in the plates is radially graded into two zones. Burn up calculations show that at 20 MW power the maximum thermal flux in the D_2O is always larger than 8×10^{14} cm^{-2} s^{-1} during a reactor cycle of more than 40 days. The maximum heat flux density is below 550 W/cm^2 even without burnable poison. For LEU fuel the thermal neutron flux maximum would be smaller by about one third.

21770 (ANL/RERTR/TM–9, pp. 435-448) **Summary of the studies carried out for the definition of the maximum allowed heat flux in the BR2 reactor.** de West-Meerbeeck, A.B. (Belgian Nuclear Research Centre, Mol (Belgium)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The maximum allowed heat flux is defined following measurements of the cladding temperature performed in the year 1963 in steady hydraulic conditions and during the flow inversion occurring after a core cooling perturbation. Two-phase flow calculations have implemented the criterion of flow instability and the safety during an incident of power excursion with automatic power reduction by control rods. The influence of the thickness of the water gap on the maximum allowed heat flux is also given.

21771 (ANL/RERTR/TM–9, pp. 449-460) **Thermal-hydraulic aspects of flow inversion in a research reactor.** Smith, R.S.; Woodruff, W.L. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

PARET, a neutronics and thermal-hydraulics computer code, has been modified to account for natural convection in a reactor core. The code was then used to analyze the flow inversion that occurs in a reactor with heat removal by forced convection in the downward direction after a pump failure. Typical results are shown for a number of parameters. Research reactors normally operating much above ten MW are predicted to experience nucleate boiling in the event of a flow inversion. Comparison with experimental results from the Belgian BR2 reactor indicated general agreement although nucleate boiling that was analytically predicted was not noted in the BR2 data.

21772 (ANL/RERTR/TM–9, pp. 461-472) **Experimental investigation of onset of nucleate boiling in this rectangular channels.** Belhadj, M. (Ohio State Univ., Columbus (USA)); Christensen, R.N.; Aldemir, T. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and

Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The 10 kW, HEU fueled Ohio State University Research Reactor (OSURR) will be upgraded to operate with plate type LEU U_3Si_2, fuel elements in the power range 250-500 kW. The core will be cooled by natural convection and an onset of nucleate boiling (ONB) margin of 1.2 will be maintained in the hot channel under steady-state operation. The validity of the correlations used for predicting ONB in plate type research reactors is not known for low heat flux-low velocity flows. An experiment has been set up at The Ohio State University to investigate ONB for laminar flow in this rectangular channels. The results show that: The Bergles-Rohsenow correlation and the correlation proposed by Ricque and Siboul predict higher and lower ONB fluxes than actual, respectively. The ONB heat flux is flow velocity dependent.

21773 (ANL/RERTR/TM–9, pp. 473-487) **Thermal-hydraulic analysis of the OSURR pool for power upgrade with natural convection core cooling.** Ha, J.J. (Ohio State Univ., Columbus (USA)); Aldemir, T. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Natural convection mode core cooling will be maintained in the LEU conversion/power upgrade of The Ohio State University Research Reactor (OSURR) to 250-500 kW. The pool water will be cooled by a water-glycol-air and a water-water heat exchanger. A plume disperser will be installed in the pool to minimize evaporation from the pool top and to maintain the dose rate due to N-16 activity within allowable levels. The minimization of the pool heat removal system operation costs necessitates maximizing the inlet temperature to the water-glycol-air heat exchanger. For the maximization process, the change in the pool temperature and velocity fields have to be investigated as a function of: location and orientation of the heat removal system components and the plume disperser in the pool; mass flow rate through the plume disperser. The velocity and temperature fields in the pool are determined using COMMIX-1A. The computational system model accounts for the presence of all the pool components (i.e. core, thermal column, beam ports, ion chamber, guide tubes, rabbit, neutron source etc.). The results show that: (1) Both the heat removal system inlet point and the plume disperser have to be located close to the top of the core. (2) Using a disperser system consisting of several pipes may be more feasible than a single unit. (3) For high disperser flow, the disperser jet has to be almost parallel to the top of the core to prevent flow reversal in coolant channels. (4) More than one disperser system may be necessary to create an inversion layer in the pool.

21774 (ANL/RERTR/TM–9, pp. 491-499) **Measurements and analysis of critical experiments in the La Reina reactor using medium enrichment uranium fuel.** Klein, J. (Comision Chilena de Energia Nuclear, Santiago (Chile)); Mutis, O.; Venegas, R. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The 5 MW La Reina reactor became critical on January 23, 1985 with 20 medium enrichment uranium fuel elements. Experiments were carried out to measure the change in critical core configuration characteristics between the previous highly enriched uranium fuel and the new medium enriched uranium fuel. This paper provides the results of measurements concerning with the critical approach, the axial flux distribution, the reflector savings and the excess reactivity, including results of neutronic calculations made for the critical experiment.

21775 (HEDL-TC–1933) **Engineering test plan for US/UK higher actinides irradiations tests.** Basmajian, J.A. Hanford Engineering Development Lab., Richland, WA (USA). Mar 1981. 66p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76FF02170. Order Number DE90007175. Available from NTIS, PC A04/MF A01 - OSTI.

The objective of the Higher Actinides Irradiations Program is to verify the neutronic and irradiation performance of americium and curium oxides in a fast reactor. The data obtained from the irradiation will be used to assess the basic neutronics parameters for actinide elements and determine the irradiation potential of the oxides of ^{241}Am and ^{244}Cm. This information has application in breeder reactor physics, fuel cycle analysis and assessment of waste management options. The irradiation test program is a cooperative effort wherein the US is supplying the completed irradiation test pins, while the UK will perform the irradiation in their Prototype Fast Reactor (PFR). Postirradiation examination and data analyses will be conducted on a cooperative basis, with some examinations performed in the UK and others in the US. 5 figs., 5 tabs.

21776 (IAE–2053/E-6/R/A) **The analysis of the probability of the brittle fracture of the reactor EWA construction elements.** Szpunar, E. Institute of Atomic Energy, Otwock-Swierk (Poland). Jan 1988. 59p. (In Russian). Order Number DE90620256. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Received in 1989.

The results of structure and corrosion investigations, analysis of loads, performance technology and analysis of probability of brittle fracture of the materials used for blanket and carrying-plate of reactor EWA separator in non-irradiated state were described. The value of the fast neutrons fluence was appreciated in the most neuralgic points of the separator. Using other construction elements as well as the 4 groups of the surveillance samples from MARIA reactor, the changes of the mechanical properties of PAR-1 alloy in dependence of the fluence were established. These results served for the estimation of the mechanical properties of the blanket and carrying-plate of the separator in the most endangered places. 9 refs., 24 figs., 12 tabs. (author).

21777 (JAERI-M–89-161) **Design criteria, production and total integrity assessment of fuels of the High Temperature Engineering Test Reactor.** Hayashi, Kimio (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Shiozawa, Shunsaku; Sawa, Kazuhiro; Sato, Sadao; Maruyama, Soh; Kobayashi, Fumiaki; Fukuda, Kousaku. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 90p. (In Japanese). Order Number DE90759888. Available from NTIS (US Sales Only), PC A05/MF A01.

This report describes the design criteria, production and total integrity of the HTTR fuels for the safety design of the reactor. The fuels were designed so that they should not lose their integrity even though taking account of various kinds of possible deteriorations during reactor service. Sufficiently low values of initial (as-produced) fuel failure fractions have been achieved, and experience of fuel production is enough for full core loading. Results of the present assessment have shown that total integrity of the fuels will be maintained successfully in terms of coating failure of the fuel particles, thermal and mechanical performance of the fuel compacts, graphite sleeves and fuel assemblies. (author).

21778 (JAERI-M–89-162) **Assessment of fuel integrity of the High Temperature Engineering Test Reactor (HTTR) and its permissible design limit.** Hayashi, Kimio (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Sawa, Kazuhiro; Shiozawa, Shusaku; Fukuda, Kousaku. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 88p. (In Japanese). Order Number DE90759923. Available from NTIS (US Sales Only), PC A05/MF A01.

This report describes the results of integrity assessment of the HTTR fuel as a part of safety design of the reactor. Functions of individual coating layer of the coated fuel particles were investigated to clarify the characteristic properties of the HTTR fuel. Integrity of the fuel under normal operating conditions of HTTR was shown to be maintained through analyses on fuel failure and due to kernel migration (amoeba effect) and corrosion of the silicon carbide layer by palladium. The fuel integrity has been demonstrated by successful results of the irradiation performance tests. By considering the failure behavior of coated fuel particles, the permissible design limit of the fuel was determined such that the fuel

temperature should not exceed 1600degC under abnormal transient conditions. The validity of the determination of the limit has been confirmed by results of heating experiments of coated fuel particles at extremely high temperature. (author).

21779 (KURRI-TR–318, pp. 77-82) **A new high temperature ion source for the KUR-ISOL facility.** Karlewski, T. (Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie); Kawase, Y.; Okano, K. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

To obtain high efficiencies for monoxide ions of light neutron-rich lanthanides formed in the thermal neutron induced fission of ^{235}U at the KUR-ISOL facility, a new high temperature ion source has been designed and first experiments are described. To compare this ion source with the former and a similar one used at the HELIOS separator at Mainz, a simple model to calculate the skimmer efficiency is discussed briefly. The model shows that with an estimated efficiency of about 50 % the solid angle transmission of the new ion source is comparable to other systems. (author).

21780 (KURRI-TR–319, pp. 9-12) **Measurement and analysis on coupled cores in the KUCA.** Misawa, Tsuyoshi (Kyoto Univ. (Japan). Faculty of Engineering (Japan)); Shiroya, Seiji; Kanda, Keiji. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8808287–: 3. KURRI symposium on criticality safety, Kumatori (Japan), 8 Aug 1988). In *Proceedings of the 3rd KURRI symposium on criticality safety.* Order Number DE90741372. Available from NTIS (US Sales Only), PC A05/MF A01.

Published in summary form only. KUCA REACTOR/criticality; COUPLED REACTOR CORES/kuca reactor; CRITICALITY; REACTOR NOISE; FEYNMAN METHOD; MULTIPLICATION FACTORS; NEUTRON FLUX; HE-3 COUNTERS; PROMPT NEUTRONS

21781 (ORNL/M–898) **Optimization of the PS-2 core configuration for the ANS [Advanced Neutron Source] Reactor.** West, C.D. Oak Ridge National Lab., TN (USA). 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007608. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The preconceptual design phase of the Advanced Neutron Source (ANS) Project ended with the selection of a reference reactor core that will be used to begin conceptual design work. In this memo, the correlations among various performance parameters that were evaluated numerically in the reference core design effort are treated analytically to yield closed-form solutions. The results can be used to optimize the core dimensions for various performance requirements and to verify some of the numerical calculational methods employed earlier. 1 ref., 1 fig., 3 tabs.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 21446, 21447, 21746, 21747, 21748, 21749, 21750, 21751, 21752, 21753, 21754, 21755, 21756, 21757, 21758, 21759, 21760, 21761, 21762, 21763, 21764, 21765, 21766, 21771, 21790, 21792, 21806, 22210, 22211, 22544

21782 (ANL/RERTR/TM–9, pp. 132-141) **Pilot plant production at Riso of LEU silicide fuel for the Danish reactor DR3.** Toft, P. (Riso National Lab., Roskilde (Denmark)); Borring, J.; Adolph, E. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

A pilot plant for fabricating LEU silicide fuel elements has been established at Riso National Laboratory. Three test elements for the Danish reactor DR3 have been fabricated, based on 19.88% enriched U_3Si_2 powder that has been purchased elsewhere. The pilot plant has been set up and 3 test elements fabricated without any major difficulties.

21783 (ANL/RERTR/TM–9, pp. 392-409) **Analysis of uranium silicide fuel for the Ford nuclear reactor.** Martin, W.R. (Univ. of Michigan, Ann Arbor (USA)); Nakata, H.; Wan, T.C.; Vujic, J.; Lee, J.C. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

This paper presents the preliminary results of a feasibility analysis for the utilization of uranium silicide fuel int he Ford Nuclear Reactor operated by The University of Michigan. The higher uranium content in the large silicide core resulted in an increased cycle length and hence very high discharge burnup is possible, with consequent decrease in the number of fuel elements added to the core annually. For smaller silicide cores the thermal flux distribution increased about 20% in the D_2O tank and also a larger shutdown margin was observed compared to those for the reference aluminide core. The maximum power densities, however, were increased in all silicide cores and for the large silicide cores the shutdown margin is slightly smaller than that for the reference aluminide core.

21784 (ANL/RERTR/TM–9, pp. 500-513) **Physical behavior of the high flux engineering test reactor.** Feng, P. (Reactor Operating Institute, Sichuan (China)); Yongxi, B. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

This paper describes the main physical characteristics of the design, operation, and experimental measurements of the High Flux Engineering Test Reactor (HFETR), located at the Southwest Centre of Reactor Research and Design (SWCR), Chengdu, Southwest China. Suggestions about research directed toward reducing the enrichment of fuel in HFETR are given.

21785 (DOE/NP–0002) **Assurance for the future.** USDOE Office of Environment, Washington, DC (USA). Office of New Production Reactors. Jan 1990. 16p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90007644. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effectiveness of our nation's deterrent capability is dependent not only on the nuclear weapons we have or can produce, but also on our ability to reliably produce the nuclear materials, including a rare gas known as tritium, needed for those weapons. The Department of Energy is responsible for producing these nuclear materials to meet requirements determined by the Department of Defense. Over the last 40 years, the Department of Energy has built and operated as many as 14 reactors to produce nuclear materials. Today, however, most of those reactors have been shut down, and although the remaining reactors capable of producing nuclear materials, they cannot last indefinitely. This document discusses the technology and the need for new production reactors.

21786 **Silver, copper, and honest-to-god copper.** Seaborg, G.T. (Lawrence Berkeley Lab., CA (USA)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 16-17 (Nov 1989).

This paper discusses how the discovery of the transuranic element now known as plutonium and its subsequently scaled-up production during the Manhattan Project was brought about by many people solving difficult chemical problems. The early history surrounding the discovery of plutonium is described.

2209 Reactor Safety

Refer also to citation(s) 21469, 21689, 21699, 21700, 21702, 21714, 21720, 21732, 21741, 21742, 21745, 21785, 22202, 22255, 22279, 22280, 22281, 22541, 22544, 22601

21787 (BMU–1989-230) **Evaluation of PWR transients with highest pressure increase for the ATWS case 'loss of main**

feedwater supply'. Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Frisch, W.; Hoeld, A. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Mar 1989. 65p. (In German). Contract BMU SR 271/3. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

The entire spectrum of transients analyzed during commissioning has been evaluated with respect to the potential of exceeding the primary system design pressure. The systematic evaluation indicates that during the ATWS case 'loss of main feedwater supply' the highest primary system pressure is obtained. This case has been analyzed in detail, and it has been indicated which degree of detail is necessary in the simulation. In addition, sensitivity calculations have been performed to find such parameters which influence the value of the maximum system pressure. (orig.).

21788 (BNL-NUREG–43069) **Reactivity accidents: A reassessment of the design-basis events.** Diamond, D.J.; Hsu, Chia-Jung; Fitzpatrick, R.; Mirkovic, D. Brookhaven National Lab., Upton, NY (USA). [1989]. 25p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–16: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Order Number DE90006725. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper summarizes a study of light water reactor event sequences which have been investigated for their potential to result in reactivity accidents with severe consequences. The study is an outgrowth of the concern which arose after the accident at Chernobyl and was recommended by the report of the US Nuclear Regulatory Commission (NRC) on the implications of that accident (NUREG-1251). The work was done for the NRC to reconfirm or bring into question previous judgments on reactivity events which must be analyzed for licensing. Event sequences were defined and then a probabilistic assessment was completed to estimate the frequency of the reactivity event and/or a deterministic calculation was completed to estimate the consequences to the fuel. Using the results of this analysis, analysis done by others, and a set of screening criteria developed within this study, judgments were made for each sequence as to its importance, and recommendations were made as to whether the NRC ought to be considering the important sequences as part of the design basis or for further, more detailed, investigation. 31 refs., 9 figs., 1 tab.

21789 (CONF-9003100–1) **The ORNL [Oak Ridge National Laboratory] liquid nitrogen simulation facility.** Eberle, C. Oak Ridge National Lab., TN (USA). [1990]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International workshop on cold neutron sources; Los Alamos, NM (USA); 5-8 Mar 1990. Order Number DE90008399. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The ANS cold neutron sources will experience more severe operating conditions than do existing cold sources. A liquid nitrogen simulation facility is being built to address the issues raised by operating at conditions not previously experienced. This paper discusses the ANS cold source heat loading, explains why liquid nitrogen was chosen as the simulant, describes the simulation facility, and discusses planned tests with test objectives. 13 refs., 10 figs., 3 tabs.

21790 (DOE/ER/35012–T3) **Safety issues at the defense production reactors: A report to the US Department of Energy.** National Research Council, Washington, DC (USA). Committee to Assess Safety and Technical Issues at DOE Reactors. 1987. 261p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-86ER35012. Order Number DE90007269. Available from NTIS, PC A07/MF A01; OSTI; INIS.

The United States produces plutonium and tritium for use in nuclear weapons at the defense production reactors–the N Reactor in Washington and the Savannah River reactors in South Carolina. This report reaches general conclusions about the management of those reactors and highlights a number of safety and technical issues that should be resolved. The report provides an assessment of the safety management, safety review, and safety methodology employed by the Department of Energy and the private contractors who operate the reactors for the federal government. The report is necessarily based on a limited review of the defense production reactors. It does not address whether any of the reactors are "safe," because such an analysis would involve a determination of acceptable risk–a matter of obvious importance, but one that was beyond the purview of the committee. It also does not address whether the safety of the production reactors is comparable to that of commercial nuclear power stations, because even this narrower question extended beyond the charge to the committee and would have involved detailed analyses that the committee could not undertake.

21791 (DOE/ID–10238) **Modeling of in-vessel fission product release including fuel morphology effects for severe accident analyses: Advanced Reactor Severe Accident Program.** Suh, K.Y. (Fauske and Associates, Inc., Burr Ridge, IL (USA)). EG and G Idaho, Inc., Idaho Falls, ID (USA); Fauske and Associates, Inc., Burr Ridge, IL (USA). Oct 1989. 34p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–89060). Order Number DE90007065. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new in-vessel fission product release model has been developed and implemented to perform best-estimate calculations of realistic source terms including fuel morphology effects. The proposed bulk mass transfer correlation determines the product of fission product release and equiaxed grain size as a function of the inverse fuel temperature. The model accounts for the fuel-cladding interaction over the temperature range between 770 K and 3000 K in the steam environment. A separate driver has been developed for the in-vessel thermal hydraulic and fission product behavior models that were developed by the Department of Energy for the Modular Accident Analysis Package (MAAP). Calculational results of these models have been compared to the results of the Power Burst Facility Severe Fuel Damage tests. The code predictions utilizing the mass transfer correlation agreed with the experimentally determined fractional release rates during the course of the heatup, power hold, and cooldown phases of the high temperature transients. Compared to such conventional literature correlations as the steam oxidation model and the NUREG-0956 correlation, the mass transfer correlation resulted in lower and less rapid releases in closer agreement with the on-line and grab sample data from the Severe Fuel Damage tests. The proposed mass transfer correlation can be applied for best-estimate calculations of fission products release from the UO_2 fuel in both nominal and severe accident conditions. 15 refs., 10 figs., 2 tabs.

21792 (DPST–73-225) **Re-evaluation of $BOSF_N$ limits.** Hodges, M.W.; Knoebel, D.H.; Wingo, H.E. Savannah River Lab., Aiken, SC (USA). 3 Jul 1973. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90007718. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Burnouts occurred on Mark 18 fuel assemblies during the CF-I production campaign. To reduce the frequency of burnouts, the $BOSF_N$ operating limit was increased sequentially until a 30% arbitrary increase resulted with no additional burnouts. Because $BOSF_N$ limits for all charges were derived using the same analysis and the cause of the failures was unknown, the same 30% increase in $BOSF_N$ operating limit was applied to all assemblies having coextruded tubes. This additional pad has been maintained until the cause of the Mark 18 burnouts could be fully explained. 6 refs., 2 figs., 5 tabs.

21793 (EGG-EAST–8829) **First international workshop on severe accidents and their consequences Sochi, USSR: Progress report, 30 October–3 November 1989.** Duffey, R.B. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); McCloskey, D.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). 21 Dec 1989. 50p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8910255–Summ.: International workshop on severe accidents and their consequences, Sochi City (USSR), 30 Oct - 3 nov 1989). Order Number DE90007414. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The report contains an account of discussions that took place between the United States, European, and Soviet scientists and engineers on the Chernobyl accident progression and measures

taken to mitigate the consequences. A description is given of a study tour to the Chernobyl Nuclear Power Plant and ensuing discussions with site personnel. 28 refs., 9 figs., 3 tabs.

21794 (EPRI-NP–6147-Vol.3) **Evaluation of discrepancies in assembly cross-section generator codes: Volume 3, Assembly calculations: Final report.** Fisher, J.R. (Utility Resource Associates, Rockville, MD (USA)); Grow, R.L.; Rapp, J.S.; Smolinske, K.M.; Mint, L.S. Electric Power Research Inst., Palo Alto, CA (USA); Utility Resource Associates, Rockville, MD (USA). c Feb 1990. 67p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The capabilities of utility reactor analysis technical staffs have increased significantly over the past five to ten years. Utilities utilize different cross section generators (EPRI-CELL, CPM, CASMO), different versions of these generators and different libraries in the generators, to produce input to different nodal codes. Phase I of this project utilized available data from utility calculations to identify the areas of differences in calculated results and to make an initial assessment of the potential impact and/or consequence of these differences. Phase II of this project investigated these differences via a consortium of utilities performing calculations for pin cells and multi-pin cells using controlled input data and options. The Phase II goal was to quantify differences and to determine if the differences were due to cross section library, cross section code methodology or the procedure for utilizing a code. The Phase III goal was to investigate the significant differences from Phase II in an assembly environment to determine if the differences became smaller, larger or remained the same in the assembly environment. The Phase III assembly calculations were performed by the same group of utilities as Phase II and the cases used controlled input and code vendor input option recommendations. 10 figs., 31 tabs.

21795 (EPRI-NP–6633) **Utility industry evaluation of the Sodium Advanced Fast Reactor: Final report.** Burstein, S. (Wisconsin Electric Power Co., Milwaukee, WI (USA)); DelGeorge, L.O.; Tramm, T.R.; Gibbons, J.P.; High, M.D.; Neils, G.H.; Pilmer, D.F.; Tomonto, J.R. Electric Power Research Inst., Palo Alto, CA (USA); Wisconsin Electric Power Co., Milwaukee, WI (USA); Commonwealth Edison Co., Chicago, IL (USA); Philadelphia Electric Co., PA (USA); Tennessee Valley Authority, Knoxville, TN (USA); Northern States Power Co., Minneapolis, MN (USA); Southern California Edison Co., Rosemead, CA (USA); Florida Power and Light Co., Miami, FL (USA); Pacific Gas and Electric Co., San Francisco, CA (USA). c Feb 1990. 95p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A team of utility industry representatives evaluated the Sodium Advanced Fast Reactor plant design, a current liquid metal reactor design created by an industrial team led by Rockwell International under Department of Energy sponsorship. The utility industry team concluded that the plant design offers several attractive characteristics, especially in the safety arena, as well as preserving the traditional attraction of liquid metal reactors, very high fuel utilization. Specific comments and recommendations are provided as a contribution towards improving an already attractive plant design. 18 refs.

21796 (EPRI-NP–6644) **Utility industry evaluation of the Power Reactor Inherently Safe Module: Final report.** Burstein, S. (Wisconsin Electric Power Co., Milwaukee, WI (USA)); DelGeorge, L.O.; Tramm, T.R.; Gibbons, J.P.; High, M.D.; Neils, G.H.; Pearson, O.F.; Tomonto, J.R.; Pilmer, D.F. Electric Power Research Inst., Palo Alto, CA (USA); Wisconsin Electric Power Co., Milwaukee, WI (USA); Commonwealth Edison Co., Chicago, IL (USA); Philadelphia Electric Co., PA (USA); Tennessee Valley Authority, Knoxville, TN (USA); Northern States Power Co., Minneapolis, MN (USA); Florida Power and Light Co., Miami, FL (USA); Southern California Edison Co., Rosemead, CA (USA); Pacific Gas and Electric Co., San Francisco, CA (USA). c Feb 1990. 130p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A team of utility industry representatives evaluated the Power Reactor Inherently Safe Module plant design, a current liquid metal reactor design created by an industrial team led by General Electric under Department of Energy sponsorship. The utility industry team concluded that the plant design offers several attractive characteristics, especially in the safety arena, as well as preserving the traditional attraction of liquid metal reactor, very high utilization. Specific comments and recommendations are provided as a contribution towards improving an already attractive plant design. 11 refs., 3 figs., 4 tabs.

21797 (EPRI-NP–6647) **Utility industry evaluation of the metal fuel facility and metal fuel performance for liquid metal reactors: Final report.** Burstein, S. (Wisconsin Electric Power Co., Milwaukee, WI (USA)); Gibbons, J.P.; High, M.D.; O'Boyle, D.R.; Pickens, T.A.; Pilmer, D.F.; Tomonto, J.R. Electric Power Research Inst., Palo Alto, CA (USA); Wisconsin Electric Power Co., Milwaukee, WI (USA); Philadelphia Electric Co., PA (USA); Tennessee Valley Authority, Knoxville, TN (USA); Commonwealth Edison Co., Chicago, IL (USA); Northern States Power Co., Minneapolis, MN (USA); Southern California Edison Co., Rosemead, CA (USA); Florida Power and Light Co., Miami, FL (USA); Pacific Gas and Electric Co., San Francisco, CA (USA). c Feb 1990. 53p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A team of utility industry representatives evaluated the liquid metal reactor metal fuel process and facility conceptual design being developed by Argonne National Laboratory (ANL) under Department of Energy sponsorship. The utility team concluded that a highly competent ANL team was making impressive progress in developing high performance advanced metal fuel and an economic processing and fabrication technology. The utility team concluded that the potential benefits of advanced metal fuel justified the development program, but that, at this early stage, there are considerable uncertainties in predicting the net overall economic benefit of metal fuel. Specific comments and recommendations are provided as a contribution towards enhancing the development program. 6 refs.

21798 (EPRI-NP–6668-Vol.4) **STARRS-MMS [Secondary-Side Transport And Retention of Radioactive Species-Modular Modeling System] code: Evaluating steam generator tube ruptures: Volume 4: Application, Final report.** Ghaaisiaan, S.M. (Science Applications International Corp., Torrance, CA (USA)); Wassel, A.T. Electric Power Research Inst., Palo Alto, CA (USA); Science Applications International Corp., Torrance, CA (USA). c Feb 1990. 116p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Secondary-Side Transport And Retention of Radioactive Species (STARRS) is a computer code for the analysis of a U-Tube Steam Generator Tube Rupture (UTSGTR) event. The transient thermal-hydraulics of the primary and secondary sides, as well as the transport of radioactive species in the secondary side, are simulated. In this document the transport and retention module of STARRS is validated against MB-2 experiments, and is utilized in parametric calculations for a prototypical U-Tube steam generator. The thermal-hydraulic modules of STARRS are also validated against several MB-2 tests. Finally the coupled thermal-hydraulics and scrubbing modules are utilized in a transient analysis of an SGTR in a prototype. 23 refs., 83 figs., 27 tabs.

21799 (EPRI-NP–6708) **Progress in radiation control technology: Final report.** Ocken, H.; Wood, C.J. (eds.). Electric Power Research Inst., Palo Alto, CA (USA). c Feb 1990. 60p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report consists of four recent papers that describe developments resulting from the EPRI Radiation Control Program. The first section presents an overview of the current US industry situation in radiation control, including exposure trends and current work on cobalt replacement, controlling transport, activation and deposition. The section describes work to qualify full-system chemical decontamination. The third section outlines experience with zinc injection passivation at BWR plants in the USA. The fourth section describes the experience with elevated primary system pH at the Millstone Point Unit 3 PWR. 37 refs., 24 figs., 4 tabs.

21800 (EPRI-NP–6713) **French verification of PWR vessel integrity: Final report.** Tanon, A.P. (Framatome, 92 - Paris La

Defense (France)); Grandemange, J.; Houssin, B.; Buchalet, C. Electric Power Research Inst., Palo Alto, CA (USA); Framatome, 92 - Paris La Defense (France). c Feb 1990. 136p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents the fracture mechanics methods and criteria developed in France for fast fracture risk analysis of PWR vessel belt lines. Regulatory requirements and design code (RCC-M) provisions are presented, as well as the new set of criteria developed for a generic reevaluation of the margins with respect to fast fracture of the 900 MWe serie vessels. Emphasis is placed on features which have direct interest for the effort undertaken in the United States on improving the criteria for low temperature operation of LWR plants and evaluation of PTS conditions. The following topics are more particularly developed: the reference defects, which are defined in relation to manufacturing aspects and non destructive examination capacity; the fracture mechanics models and plasticity corrections, with comparison to elastoplastic analysis involving the criteria of the local approach of fracture; the safety margins to be met, which depend on the combined probability of the transient and reference defect class under consideration; and the French experience on defining trend curves to predict irradiation embrittlement. The case of the CHOOZ A vessel illustrates how the new set of criteria has been combined with the surveillance program and in-service inspection results for proving the vessel reliability, and allowing plant restart. 37 refs., 63 figs., 24 tabs.

21801 (IAE–2061/E-1/D/A) **The body contents of gamma emitters in adults after the Chernobyl accident and an estimation of exposure for intakes in 1986.** Cwik, T.; Deszczak, T. Institute of Atomic Energy, Otwock-Swierk (Poland). Jun 1988. 63p. (In Polish). Order Number DE90619675. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Received in Nov 1989.

The measuring equipment parameters as well as the results measurement and processing methods applied for estimating the individual body contents of the photon emitters released during the nuclear reactor accident at Chernobyl are presented. The results of estimations of ^{131}I contents in the thyroid and of ^{103}Ru, ^{136}Ru, ^{134}Cs and ^{137}Cs contents in the whole body, based on the measurements performed till the end of 1986 are given. It was observed that the body contents of both the caesium isotopes had been increasing till the end of 1986, which is indicative of prolonged intakes. The average and maximum levels of the committed doses in the thyroid due to ^{131}I uptakes as well as the doses absorbed by the whole body as a result of ^{134}Cs and ^{137}Cs intakes in 1986 have been estimated for the Warsaw region population. 5 refs., 8 figs., 8 tabs. (author).

21802 (IAEA-TECDOC–524) **Status, experience and future prospects for the development of probabilistic safety criteria: Report of a technical committee meeting held in Vienna, 27-31 January 1986.** International Atomic Energy Agency, Vienna (Austria). Sep 1989. 241p. (CONF-860145–: IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic criteria, Vienna (Austria), 27-31 Jan 1986). Order Number DE90620170. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

During 27-31 January 1986 the IAEA held a Technical Committee Meeting on "Status, Experience, and Future Prospects for the Development of Probabilistic Safety Criteria". Participation included representation of essentially all countries with major developments in the area as well as the Nuclear Energy Agency of the OECD and CEC. Though it has to be recognized that in such a short time period it is impossible to resolve or even analyse all aspects of this complex issue, the present situation, the main problems and the directions for future work clearly emerged. This report was prepared by the members of the Technical Committee based on the opinions expressed and on the information available at the time of the meeting. The report also contains 20 papers presented at the meeting by participants. A separate abstract was prepared for each of these 20 papers. Refs, figs and tabs.

21803 (JAERI-M–89-184) **Reactor accident diagnostic expert system: DISKET.** Yoshida, Kazuo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Yokobayashi, Masao. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 168p. (In Japanese). Order Number DE90759928. Available from NTIS (US Sales Only), PC A08/MF A01.

A reactor accident diagnostic system DISKET has been developed to identify the cause and the type of an abnormal transient of a nuclear power plant. The system is based on the knowledge engineering and consists of an inference engine IERIAS and a knowledge base. The main features of DISKET are the following: Time-varying characteristics of transient can be treated and knowledge base can be divided into several knowledge units to handle a lot of rules effectively. This report has been provided for the convenience of DISKET's users and consists of three parts. The first part is the description of the whole system, the details of the knowledge base of DISKET are described in the second part, and how to use the DISKET system is explained in the third part. (author).

21804 (NUREG–0090-Vol.12-No.3) **Report to Congress on abnormal occurrences, July–September 1989.** Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data. Jan 1990. 34p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event that the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report covers the period from July 1 to September 30, 1989. For this reporting period, there were five abnormal occurrences. One abnormal occurrence took place at a licensed nuclear power plant and involved significant deficiencies associated with the containment recirculation sump at the Trojan facility. The other four abnormal occurrences took place under other NRC-issued licenses: the first involved a medical diagnostic misadministration; the second involved a medical therapy misadministration; the third involved a radiation overexposure of a radiographer; and the fourth involved a significant breakdown and careless disregard of the radiation safety program at three of a licensee's manufacturing facilities. The Agreement States reported no abnormal occurrences during the reporting period. The report also contains information that updates some previously reported abnormal occurrences. 17 refs.

21805 (NUREG–0797-Suppl.23) **Safety Evaluation Report related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2 (Docket Nos. 50-445 and 50-446).** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Feb 1990. 98p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Supplement 23 to the Safety Evaluation Report related to the operation of the Comanche Peak Steam Electric Station (CPSES), Units 1 and 2 (NUREG-0797), has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission (NRC). The facility is located in Somervell County, Texas, approximately 40 miles southwest of Fort Worth, Texas. This supplement reports the status of certain issues that had not been resolved when the Safety Evaluation Report and supplements 1, 2, 3, 4, 6, 12, 21, and 22 to that report were published. This supplement also includes the evaluations for licensing items resolved since Supplement 22 was issued. Supplement 5 has not been issued. Supplements 7, 8, 9, 10, and 11 were limited to the staff evaluation of allegations investigated by the NRC Technical Review Team. Supplement 13 presented the staff's evaluation of the Comanche Peak Response Team (CPRT) Program Plan, which was formulated by the applicant to resolve various construction and design issues raised by sources external to TU Electric. Supplements 14 through 19 presented the staff's evaluation of the CPSES Corrective Action Program: large- and small-bore piping and pipe supports (Supplement 14); cable trays and cable tray hangers (Supplement 15); conduit supports (Supplement 16); mechanical, civil/structural, electrical, instrumentation and controls, and systems portions of the heating, ventilation, and air conditioning (HVAC) system workscopes (Supplement 17); HVAC structural design

(Supplement 18); and equipment qualification (Supplement 19). Supplement 20 presented the staff's evaluation of the Comanche Peak Response Team implementation of the CPRT Program.

21806 (NUREG–1381) **Technical specifications: Comanche Peak Steam Electric Station, Unit 1 (Docket No. 50-445): Appendix "A" to license No. NPF-28.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Feb 1990. 353p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A16/MF A01; OSTI; INIS.

This report gives technical specifications for the Comanche Peak-1 Reactor Nuclear Power Station, and Docket No 50–445 of the US NRC. (FSD)

21807 (NUREG/CP–0097-Vol.3, pp. 1-20) **Condition monitoring and aging assessment of Class 1E cables.** Jacobus, M.J. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Sandia National Laboratories is currently conducting long-term aging research on representative samples of nuclear power plant Class 1E cables. The objectives of this program are to determine the suitability of these cables for extended life (beyond 40 year design basis) and to assess various cable condition monitoring (CM) techniques for predicting remaining cable life. The cables are being aged for long times at relatively mild exposure conditions with various CM techniques being employed during the aging process. Following the aging process, the cables will be exposed to a sequential accident profile consisting of high dose rate irradiation followed by a simulated design basis loss-of-coolant accident (LOCA) steam exposure. This paper covers two aspects of the research program: the electrical measurement techniques that have been developed and are being performed and some initial data that has been generated from these measurement techniques. The electrical measurements include insulation resistance, polarization index, capacitance, and dissipation factor. 19 refs., 7 figs., 2 tabs.

21808 (NUREG/CP–0097-Vol.3, pp. 21-40) **Time domain spectroscopy to monitor the condition of cable insulation.** Mopsik, F.I. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Martzloff, F.D. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The use of Time Domain Spectroscopy, the measurement of dielectric constant and loss using time-domain response, the monitoring the aging of reactor cable insulation is examined. The method is presented, showing its sensitivity, accuracy and wide frequency range. The method's ability to acquire a great deal of information in a short time and its superiority to conventional single frequency data is shown. Different cable samples are examined before and after exposure to radiation and changes with exposure are clearly seen to occur. Also it is shown that a wide range of behavior can be found in different insulation systems. The requirements for performing valid measurements is presented. The need for controlled samples and correlation with other criteria for aging is discussed. 14 refs., 9 figs.

21809 (NUREG/CP–0097-Vol.3, pp. 41-58) **Lessons learned to date from the Shippingport aging evaluation.** Allen, R.P. (Pacific Northwest Lab., Richland, WA (USA)); Johnson, A.B. Jr. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

More than 200 naturally aged components and samples, ranging in size from small instruments and metallurgical specimens to one of the main coolant pumps, have been removed in conjunction with the decommissioning of the Shippingport Atomic Power Station and shipped to designated NRC contractors. In-situ assessments of selected Shippingport Station systems and components also have been conducted. Although the detailed evaluation of the naturally aged components and materials from the Shippingport Station is just beginning, there are a number of preliminary studies and results that are indicative of the value of the aging information that ultimately will be obtained. This paper presents background information on the Shippingport Station and its history, discusses the selection and relevancy of the naturally aged components and materials obtained through the Nuclear Plant Aging Research (NPAR) program, and illustrates the type of important plant aging information that can be derived from the in-situ studies and detailed evaluation of the components and samples from the Shippingport Station. 8 refs., 7 figs., 2 tabs.

21810 (NUREG/CP–0097-Vol.3, pp. 59-83) **Aging assessment and mitigation for major LWR components.** Shah, V.N. (Idaho National Engineering Lab., Idano Falls (USA)); Ware, A.G.; Conley, D.A.; MacDonald, P.E.; Burns, J.J. Jr. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper summarizes some of the results of the Aging Assessment and Mitigation Project sponsored by the US Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. The objective of the project is to understand the aging degradation of the major light water reactor (LWR) structures and components and develop methods for predicting the useful life of these components, so that the impact of aging on the safe operation of nuclear power plants can be evaluated and addressed. Researchers are accomplishing this objective by integrating, evaluating, and updating the available aging-related information. This paper discusses current accomplishments and summarizes the significant degradation processes active in two major components: pressurized water reactor pressurizer surge and spray lines and nozzles, and light water reactor primary coolant pumps. This paper also evaluates the effectiveness of the current inservice inspection programs and presents conclusions and recommendations related to aging of these two major components. 32 refs., 7 figs., 3 tabs.

21811 (NUREG/CP–0097-Vol.3, pp. 97-107) **Nuclear plant aging study of residual heat removal systems.** Lofaro, R. (Brookhaven National Lab., Upton, NY (USA)); Gunther, W.; Subudhi, M.; Taylor, J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The effects of aging on Residual Heat Removal systems in Boiling Water Reactors have been studied as part of the Nuclear Plant Aging Research program. The aging phenomena has been characterized by analyzing operating experience from various national data bases. In addition, actual plant data was obtained to supplement and validate the data base findings. Time-dependent failure rates were calculated for several components to identify aging trends. A computer program was developed and implemented to

model a typical RHR system and perform time-dependent Probabilistic Risk Assessment calculations. Using the time-dependent failure rates calculated from the data, the effects of aging on system unavailability and component importance were investigated. 10 refs., 12 figs.

21812 (NUREG/CP–0097-Vol.3, pp. 85-95) **The effects of aging on the fire vulnerability of nuclear power plant components.** Nowlen, S.P. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Sandia National Laboratories, under the sponsorship of the US Nuclear Regulatory Commission, has initiated an effort to identify and investigate potential nuclear power plant fir safety issues associated with plant aging. The issues of potential concern, which have been identified, are the effects of aging on (1) the vulnerability of electrical equipment to fire induced damage; (2) the propensity with which electrical equipment will initiate, or contribute to the severity of, fires; and (3) the integrity of passive fire protective features. Efforts in this program were initiated late in fiscal year 1988. For fiscal year 1989 efforts will focus on the investigation of the effects of aging on able damageability and cable flammability. This paper presents the findings of a limited review of past electrical equipment fire aging research and a summary of planned activities for fiscal year 1989. 11 refs., 4 figs.

21813 (NUREG/CP–0097-Vol.3, pp. 131-141) **Safety implications of diesel generator aging management.** Hoopingarner, K.R. (Pacific Northwest Lab., Richland, WA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Significant safety improvements can be achieved in diesel-generator management related to aging, testing, and other important regulatory concerns. This paper reports on the progress of aging research related to nuclear service diesel generators, which developed data and information supporting the recommended safety improvements. The key to diesel-generator safety improvements is the development of a new balanced approach where testing, inspections, monitoring and trending, training, and maintenance all have appropriate importance. Safety improvement is projected in a management program that concurrently achieves three goals: first, the reduction of the fast-start stressor by regulatory and utility actions; second, the establishment of more appropriate testing and trending procedures; third, the adoption and use of reliability-centered maintenance activities. This paper describes the recommended safety improvements and the positive role of utility management in the process and outlines a new recommended regulatory approach. Diesel generator aging and wear is the subject of research sponsored by the Nuclear Plant Aging Research (NPAR) Program under the US Nuclear Regulatory Commission (NRC). Office of Nuclear Regulatory Research. The research was conducted by Pacific Northwest Laboratory (PNL), which is operated for the US Department of Energy by Battelle Memorial Institute. 4 refs., 1 fig., 1 tab.

21814 (NUREG/CP–0097-Vol.3, pp. 157-173) **PRAAGE-1988: An interactive IBM-PC code for aging analysis of NUREG-1150 systems.** Fullwood, R.R. (Brookhaven National Lab., Upton, NY (USA)); Shier, W.G. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Probabilistic Risk Assessments (PRA) contain a great deal of information for estimating the risk of a nuclear power plant but do not consider aging. PRAAGE (PRA+AGE) is an interactive, IBM-PC code for processing PRA-developed system models using non-aged failure rate data in conjunction with user-supplied time-dependent nuclear plant experience component failure rate data to determine the effects of component aging on a system's reliability as well as providing the age-dependent importances of various generic components. This paper describes the structure, use and application of PRAAGE to the aging analysis of the Peach Bottom 2 RHR system in the LPCI and SDC modes of operation. 4 refs., 15 figs., 5 tabs.

21815 (NUREG/CP–0097-Vol.3, pp. 185-212) **Probability of crack-induced failure in the BWR recirculation piping.** Holman, G.S. (Lawrence Livermore National Lab., CA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The Lawrence Livermore National Laboratory (LLNL) has estimated the probability of double-ended guillotine break (DEGB) in the reactor coolant piping of Mark I boiling water reactor (B and R) plants. Two causes of pipe break are considered: crack growth at welded joints and the seismically-induced failure of component supports. For the former a probabilistic fracture mechanics model is used, for the latter a probabilistic support reliability model. This paper describes a probabilistic model developed to account for effects of intergranular stress corrosion cracking (IGSCC). The IGSCC model, based on experimental and field data compiled from several sources, correlates times to crack initiation and crack growth rates for Types 304 and 316NG stainless steel against material-specific damage parameters which consolidate the separate effects of coolant environment (temperature, dissolved oxygen content, level of impurities), stress (including residual stress), and degree of sensitization. Application of this model to actual BWR recirculation piping shows that IGSCC clearly dominates the probability of failure in 304SS piping, mainly due to cracks that initiate within a few years after plant operation has begun. Replacing Type 304 piping with 316NG reduces failure probabilities by several orders of magnitude. 11 refs., 16 rigs., 1 tab.

21816 (NUREG/CP–0097-Vol.3, pp. 109-129) **Nuclear plant aging research on the high pressure injection system.** Meyer, L.C. (Idaho National Engineering Lab., Idaho Falls (USA)); Magleby, H.L. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper presents the results of a review of light water reactor High-Pressure Injection System (HPIS) operating experiences reported in the Nuclear Power Experience Data Base, Licensee Event Reports, Nuclear Plant Reliability Data System, and plant records. The purpose of the review is to evaluate the potential significance of aging as a contributor to degradation of the HPIS. Tables are presented that show the percentage of events for HPIS classified by cause, component, and subcomponents for pressurized water reactors. A representative Babcock and Wilcox plant was selected for a detailed study. The US Nuclear Regulatory Commission's Nuclear Plant Aging Research guidelines were followed in performing the detailed study that identifies components

susceptible to aging, stressors, degradation mechanisms, and failure modes for the HPIS. In addition to the engineering evaluation, the risk-significant components were determined and the aging contribution to risk was evaluated for the HPIS studied. The risk analysis utilized an existing PRA, the linear aging model and generic failure cause data. 7 refs., 5 figs., 8 tabs.

21817 (NUREG/CP–0097-Vol.3, pp. 143-155) **Aging assessment of PWR auxiliary feedwater systems.** Casada, D.A. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

In support of the Nuclear Regulatory Commission's Nuclear Plant Aging Research (NPAR) Program, Oak Ridge National Laboratory is conducting a review of Pressurized Water Reactor Auxiliary Feedwater Systems. Two of the objectives of the NPAR Program are to identify failure modes and causes and identify methods to detect and track degradation. In Phase I of the Auxiliary Feedwater System study, a detailed review of system design and operating and surveillance practices at a reference plant is being conducted to determine failure modes and to provide an indication of the ability of current monitoring methods to detect system degradation. The extent to which current practices are contributing to aging and service wear related degradation is also being assessed. This paper provides a description of the study approach, examples of results, and some interim observations and conclusions. 1 fig., 1 tab.

21818 (NUREG/CP–0097-Vol.3, pp. 175-184) **Utilization of aging program results in plant inspections.** Gunther, W. (Brookhaven National Lab., Upton, NY (USA)); Fullwood, R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Research conducted under the auspices of the US Nuclear Regulatory Commission Nuclear Plant Aging Research (NPAR) Program has resulted in a large data base of component and system operating experience. This data base has been used to determine equipment aging susceptibility and the potential for equipment aging to impact plant safety and reliability. Methods of detecting and mitigating component and system aging have also been identified. This paper discusses how the NPAR results could be used to focus inspection activities on age-sensitive components and systems and on the specific modes and mechanisms of age degradation. These activities range from the regular inspections conducted by resident inspectors to extensive special inspections such as the Safety System Functional Inspection typically conducted by a team of inspectors. 5 refs., 3 figs., 1 tab.

21819 (NUREG/CP–0097-Vol.3, pp. 213-246) **Guillotine breaks indirectly caused by seismically-induced failures.** Holman, G.S. (Lawrence Livermore National Lab., CA (USA)); Lo, T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The Lawrence Livermore National Laboratory has developed techniques for evaluating how piping support failures caused by earthquakes would contribute to the overall probability of piping system failure. These techniques have been applied to evaluate various reactor coolant piping systems in both PWR and BWR plants. These evaluations typically found that the likelihood of pipe break due to seismically-induced support failure is small, not only for the large, stiff piping found in PWR primary systems, but for more complex, more flexible piping systems as well. We have also applied these reliability assessments have also been applied to specific regulatory issues such as the safety significance of various support failure scenarios, identifying individual supports whose failure would most serious affect system integrity, and assessing system failure on the basis of realistic failure criteria. The usefulness of such evaluations in a regulatory context has been demonstrated through recent NRC rulemaking actions, which were based in large part on the results of LLNL piping reliability studies. 8 refs., 8 figs., 6 tabs.

21820 (NUREG/CP–0097-Vol.3, pp. 247-263) **Piping and fitting dynamic reliability program.** Guzy, D.; Tagart, S.; Tang, Y.K.; English, W.; Hwang, H.; Merz, K.; DeVita, V. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

In recent years, both industry and the NRC have been concerned about the appropriateness of our piping design rules for seismic and other dynamic loads. While experimental failure data was used to justify the ASME Code's piping stress criteria for static and fatigue loads, there was little available physical evidence of piping dynamic failure behavior when the current rules were written. The NRC Piping Review Committee recognized the need to obtain such data and recommended that the NRC support a test program in this area. This resulted in the NRC's cooperation with EPRI in the Piping and Fitting Dynamic Reliability Program (PFDRP). The PFDRP was initiated in 1985 with three main objectives: (1) to identify the failure mechanisms and failure levels of piping components and systems under dynamic loadings; (2) to provide a data base that will improve our prediction of piping system response and failure due to high level dynamic loads, and (3) to develop an improved and defensible set of piping design rules for inclusion into the ASME Code. All the experimental tasks of the PFDRP have been performed Forty-one piping components failure tests were completed by ANCO Engineers. Two piping system were ruptured by high seismic-like loads at ETEC, and one of these systems was retested. The Materials Characterization Laboratory has finished testing over 140 fatigue retchetting specimens. Also, piping system waterhammer tests have been performed by ANCO Engineers. General Electric of San Jose, the prime contractor for the PFDRP, has completed most of the data reduction and analysis associated with these tests. Recommendations for improved piping rules for dynamic loads have been under developed by General Electric and should be proposed formally to the ASME in the spring of 1989. The final reports for the PFDRP will be published by EPRI in 1989. 6 figs., 2 tabs.

21821 (NUREG/CP–0097-Vol.3, pp. 265-278) **Relay studies - existing data, current testing and cabinet amplification.** Bandyopadhyay, K. (Brookhaven National Lab., Upton, NY (USA)); Hofmayer, C.; Kassir, M.; Pepper, S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The seismic fragility of most electrical equipment is governed by the malfunction of relays. This paper discusses the combined study being performed at BNL by evaluating existing fragility test data, conducting a new relay test program and estimating the cabinet amplification at relay locations. Existing test data for relays have been collected and evaluated at BNL. The data base consists of

results from a wide variety of test programs - single frequency, single axis, multifrequency, multiaxis tests. For most relays, the non-operating condition controls the chatter fragility limit. In order to characterize the effect of various parameters on the relay seismic capacity, a test program has been initiated at BNL. Selected test specimens will be tested to determine the influence of frequency of vibration, direction of motion, adjustments of relay parts, among others, on the relay capacities. The amplification study involves computing dynamic amplification factors at various device locations in motor control center and switchgear cabinets. Fragility and high level qualification data have been used for this purpose. This paper includes a summary of the amplification results. 4 refs., 6 figs., 1 tab.

21822 (NUREG/CP–0097-Vol.3, pp. 279-292) **ASCE working group activities on stiffness of concrete shear wall structures.** Bennett, J.G.; Farrar, C.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper will review the history and activities of the ASCE Working Group on stiffness of concrete shear wall structures as influenced by the US Nuclear Regulatory Commission (NRC) sponsored Seismic Category I Structures Program and their efforts to define a position for the reduced stiffness problem up through the May 1988 meeting. The group's activities and recommendations for accounting for this effect will be presented. This paper will present the authors point of view. Therefore, no warranty is implied that it will represent the final Working Group position or the ASCE Dynamic Analysis Committee acceptance. The paper is offered in the spirit of presenting the group's activities for information to the NRC and to the civil engineering community. 2 refs., 10 figs.

21823 (NUREG/CP–0097-Vol.3, pp. 293-298) **Assessment of effects of structural response on plant risk and margin.** Bohn, M.P.; Klamerus, E.W. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Since 1983, the US Nuclear Regulatory Commission Office of Nuclear Regulatory Research has sponsored the Seismic Category I Structures Program at Los Alamos National Laboratories. This project has been primarily responsible for investigating the structural dynamic response of Seismic Category I reinforced concrete shear wall structures (exclusive of containment structures). In this program, both static and dynamic tests were performed on scale model concrete shear wall structures ranging from 1/10 scale to 1/42 scale. In these tests, the structures were initially subjected to free vibration and small amplitude excitation to determine the fixed-base natural frequencies of the models. As test results accumulated, it become clear that the initial natural frequencies measured were significantly less than would be computed analytically using the initial stiffness of concrete. Furthermore, during the simulated earthquake time history tests, measured structure stiffness were found to decrease with increasing peak ground accelerations. As a result, natural frequencies of the test specimens was found to be reduced by up to 50 percent of the computed natural frequency. This reduction in natural frequencies represents a potentially important issue in the design and safety of nuclear power plants. In 1988, the US NRC began the Assessment of Effects of Structural Response of Plant Risk and Margin program at Sandia National Laboratories. The program will assess the impact of decreased natural frequencies on both the deterministic design calculations and the overall seismic plant risk for several prototypical power plants. 8 refs., 3 figs.

21824 (NUREG/CP–0097-Vol.3, pp. 299-309) **The role of parameter uncertainty in seismic risk assessment.** Ellingwood, B. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Research is underway to examine the validity and limitations of seismic PRA methods through an investigation of how various uncertainties affect risk estimates, inferences and regulatory decisions. Indications are that the uncertainty in the basic seismic hazard at the plant site appears to be the single most source of uncertainty in core damage probability. However, when the fragility modeling and plant logic are uncoupled from the seismic hazard analysis in a margin study, fragility modeling assumptions may become important. 12 refs., 3 figs., 5 tabs.

21825 (NUREG/CP–0097-Vol.3, pp. 311-337) **Progress report on the containment integrity programs.** Clauss, D.B. (Sandia National Labs., Albuquerque, NM (USA)); Parks, M.B.; Weatherby, J.R.; van Riesemann, W.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper will focus on recent progress in the Containment Integrity Programs, which are managed by Sandia National Laboratories for the US Nuclear Regulatory Commission. The overall objective of these programs is to develop reliable methods for predicting the performance of LWR containment buildings for loadings beyond their design basis. The basic assumptions and an outline of the analysis methodology are presented. The mechanics of strain concentrations that lead to liner tearing in reinforced concrete containments are explained in terms of an analytical model that accurately represents the behavior of 1:6-scale model that was tested to failure. New insights into the leakage potential of personnel airlocks and equipment hatches based on test results and analyses are described. 20 refs., 20 figs., 5 tabs.

21826 (NUREG/CP–0097-Vol.3, pp. 339-362) **SHAM: High-level seismic tests of piping at the HDR.** Kot, C.A. (Agronne National Lab., IL (USA)); Srinivasan, M.G.; Hsieh, B.J.; Malcher, L.; Schrammel, D.; Steinhilber, H.; Costello, J.F. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

As part of the second phase of vibrational/earthquake investigations at the HDR (Heissdampfreaktor) Test Facility in Kahl/Main, FRG, high-level simulated seismic tests (SHAM) were performed during April-May 1988 on the VKL (Versuchskreislauf) in-plant piping system with two servohydraulic actuators, each capable of generating 40 tons of force. The purpose of these experiments was to study the behavior of piping subjected to seismic excitation levels that exceed design levels manifold and may result in failure/plastification of pipe supports and pipe elements, and to establish seismic margins for piping and pipe supports. The performance of six different dynamic pipe support systems was compared in these tests and the response, operability, and fragility of dynamic supports and of a typical US gate valve were investigated. Data obtained in the tests are used to validate analysis methods. Very preliminary evaluations lead to the observation that, in general, failures of dynamic supports (in particular snubbers) occur only a load

levels that substantially exceed the design capacity. Pipe strains at load levels exceeding the design level threefold are quite small, and even when exceeding the design level eightfold are quite tolerable. Hence, under seismic loading, even at extreme levels and in spite of multiple support failures, pipe failure is unlikely. 5 refs., 16 figs.

21827 (NUREG/CP–0097-Vol.3, pp. 363-380) **Evaluation of aged concrete structures for continued service in nuclear power plants.** Naus, D.J. (Oak Ridge National Lab., TN (USA)); Marchbanks, M.F.; Arndt, E.G. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Results are summarized of a study on concrete component aging and its significance relative to continued service of nuclear power plants (NPPs) beyond the initial period for which they were granted operating licenses. Progress is presented of a second study being conducted to identify and provide acceptance criteria for structural safety issues which the USNRC staff will need to address when applications are submitted for continued service of NPPs. Major activities under this program include: development of a materials property data base, establishment of structural component assessment and repair procedures, and development of a methodology for determination of structural reliability. 19 refs., 5 figs., 3 tabs.

21828 (NUREG/CP–0097-Vol.3, pp. 381-397) **Application of signature analysis for determining the operational readiness of motor-operated valves under blowdown test conditions.** Haynes, H.D. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

In support of the NRC-funded Nuclear Plant Aging Research (NPAR) program, Oak Ridge National Laboratory (ORNL) has carried out a comprehensive aging assessment of Motor-Operated Valves (MOVs). As part of this work, ORNL participated in the Gate Valve Flow Interruption Blowdown (GVFIB) tests carried out in Huntsville, Alabama. The GVFIB tests were intended primarily to determine the behavior of motor-operated gate valves under the temperature, pressure, and flow conditions expected to be experienced by isolation valves in Boiling Water Reactors (BWRs) during a high energy line break (blowdown) outside of containment. In addition, the tests provided an excellent opportunity to evaluate signature analysis methods for determining the operational readiness of the MOVs under those accident conditions. ORNL acquired motor current and torque switch shaft angular position data on two test MOVs during various times of the GVFIB tests. The reduction in operating margin of both MOVs due to the presence of additional valve running loads imposed by high flow was clearly observed in motor current and torque switch angular position signatures. In addition, the effects of differential pressure, fluid temperature, and line voltage on MOV operations were observed and more clearly understood as a result of utilizing signature analysis techniques. 1 ref., 16 figs.

21829 (NUREG/CP–0097-Vol.3, pp. 399-409) **Assessment of nonintrusive methods for monitoring the operational readiness of solenoid-operated valves.** Kryter, R.C. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Solenoid-operated valves (SOVs) are being studied at Oak Ridge National Laboratory as part of the USNRC Nuclear Plant Aging Research (NPAR) Program. The primary objectives of the study is to identify and recommend methods for inspection, surveillance, and maintenance of SOVs that can ensure their operational readiness-that is, their ability to perform required safety functions under all anticipated operating conditions. An earlier (Phase I) study described SOV failure modes and causes and identified measurable parameters that might be used to monitor the various degradations that lead to functional failure. The present (Phase II) study focuses on devising and then demonstrating the effectiveness of techniques and/or equipment with which to measure the previously identified performance parameters and thus detect and trend the progress of any degradation. Several nonintrusive techniques are currently under investigation. These include the monitoring of coil mean temperature by means of dc coil resistance, the monitoring of valve position by means of coil ac impedance, and the assurance of free plunger movement through points. Techniques slated for later investigation include the monitoring of coil hum or chattering, using either acoustic sensors or electrical noise indicators, and detecting the presence of shorted turns in the solenoid coil using interrupted-current test methods.

21830 (NUREG/CP–0097-Vol.3, pp. 491-518) **Environmentally assisted cracking in light water reactors.** Shack, W.J. (Agronne National Lab., IL (USA)); Kassner, T.F.; Maiya, P.S.; Park, J.Y.; Ruther, W.E. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Research during the past year focused on (1) st ess corrosion cracking (SCC) of austenitic stainless steels (SS), (2) fatigue of Type 316NG SS, and (3) SCC of ferritic steels use din reactor piping, pressure vessels, and steam generators. Stress corrosion cracking studies on austenitic SS explored the critical strains required for crack initiation, the effects of crevice conditions on SCC susceptibility, heat-to-heat variations in SCC susceptibility of Type 316NG and modified Type 347 SS, the effect of heat treatment on the susceptibility of Type 347 SS, threshold stress intensity values for crack growth in Type 316NG SS, and the effects of cuprous ion and several organic salts on the SCC of sensitized Type 304 SS. Crevice conditions were observed to strongly promote SCC. Significant heat-to-heat variations were observed in SCC susceptibility of Types 316NG and 347 SS. No correlation was found between SCC behavior and minor variations in chemical composition. A significant effect of heat treatment was observed in Type 347 SS. A heat that was extremely resistant to SCC after heat treatment at 650°C for 24 h was susceptible to transgranular stress corrosion cracking (TGSCC) in the solution-annealed condition. Although there was no sensitization in either condition, the presence or absence of precipitates and differences in precipitate morphology appear to influence the SCC behavior. In fracture-mechanics crack-growth-rate tests on Type 316NG SS, steady-state crack growth under high R loading was observed only at stress intensity values greater than 22 $MPa \cdot m^{\frac{1}{2}}$. Cuprous ion additions were shown to be very deleterious at and above 1 ppm at 289°C; however, below 200°C, SCC occurred at much lower concentrations (0.03 ppm). SCC susceptibility tests were performed at 289°C in water containing ethylenediamine-tetraacetate (EDTA) salts at low concentrations.

21831 (NUREG/CP–0097-Vol.3, pp. 411-435) **Similarity principles for seismic qualification of equipment by experience data.** Kana, D.D. (Southwest Research Institute, San Antonio, TX (USA)); Pomerening, D.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting,

Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

A methodology is developed for seismic qualification of nuclear plant equipment by applying similarity principles to existing experience data. Experience data is that available from previous qualifications by analysis or testing, or from actual earthquake events. Similarity principles are defined in terms of excitation, equipment physical characteristics, and equipment response. Physical similarity is further defined in terms of a critical transfer function for response at a location on a primary structure, whose response can be assumed directly related to fragility of the item under elevated levels of excitation. Procedures are developed for combining experience data into composite specifications for qualification of equipment that can be shown to be physically similar to the reference equipment. Other procedures are developed for extending qualifications beyond the original specifications under certain conditions. Some examples for application and verification of the procedures are given for actual test data available from previous qualifications. The developments are intended to elaborate on the rather broad guidelines by the IEEE 344 Standards Committee for equipment qualification in new nuclear plants. The results also contribute to filling a gap that exists between the IEEE 344 methodology and that which was previously developed for equipment in existing plants by the Seismic Qualification Utilities Group. 10 refs., 9 figs., 1 tab.

21832 (NUREG/CP–0097-Vol.3, pp. 437-443) **Valve testing for UK PWR safety applications.** Bryant, S.; George, P.T.; Airey, D.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The Central Electricity Generating Board (CEGB) is currently building Sizewell B, the UK's first Civil PWR plant, and has mounted on extensive program of valve testing in support of the licensing and operation of the plant. This paper deals with the testing of valves for safety applications on Sizewell B. The BRAVO test facility has been established at the CEGB's Marchwood Laboratories to permit the full scale type testing of the pressurizer relief system valves. Tests will be carried out to confirm the performance of the valves and to develop procedures for their in service testing. Tests have also been conducted at full secondary circuit conditions on candidate Main Steam Safety Valves in the Karftwerk Union Test Facilities in W. Germany. A further test program has been established in which gate and globe valves are subjected to simulated high energy line break conditions to establish a methodology by which Sizewell valves may be qualified for this duty. It is believed that the test program will result in increased availability, reduced maintenance and increased confidence in the safety of the plant. 1 ref.

21833 (NUREG/CP–0097-Vol.3, pp. 445-466) **Piping support and gate valve behavior during high level HDR simulated seismic tests.** Steele, R. Jr. (Idaho National Engineering Lab., Idaho Falls (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper describes a portion of the analysis and results to date from the SHAM seismic research program, in which the USNRC/INEL was a participant. The program was conducted by Kernforschungszentrum Karlsruhe (KfK) at the decommissioned Heissdampfreaktor (HDR) located near Frankfurt in the Federal Republic of Germany (FRG). The research program included the study of the effects of increasing levels of seismic excitation on a full scale, in situ nuclear piping system containing a naturally aged US 8-in. motor-operated gate valve. In all, 51 experiments were conducted with the piping supported by six different piping support systems, including a typical stiff US piping support system made up of snubbers and rigid struts. Earthquake-like displacement histories were input to servohydraulic shakers attached directly to the piping system. Inputs to the piping system started with a magnitude of 0.6 g ZPA and were stepped up, using the same frequency content, to a maximum of 5 g ZPA. The resulting piping system response produced overload snubber failures and local piping strains of 0.9%. The results of this testing will contribute to the technical basis used for support and development of equipment qualification standards and will help establish the seismic safety margins in piping and piping support system components. 13 figs., 3 tabs.

21834 (NUREG/CP–0097-Vol.3, pp. 467-489) **Early results of gate valve flow interruption blowdown tests.** DeWall, K.G. (Idaho National Engineering Lab., Idaho Falls (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

The preliminary results of the USNRC/INEL high-energy BWR line break flow interruption testing are presented. Two representative nuclear valve assemblies were cycled under design basis Reactor Water Cleanup pipe break conditions to provide input for the technical basis for resolving the Nuclear Regulatory Commission's Generic Issue 87. The effects of the blowdown hydraulic loadings on valve operability, especially valve closure stem forces, were studied. The blowdown tests showed that, given enough thrust, typical gate valves will close against the high flow resulting from a line break. The tests also showed that proper operator sizing depends on the correct identification of values for the sizing equation. Evidence exists that values used in the past may not be conservative for all valve applications. The tests showed that improper operator lock ring installation following test or maintenance can invalidate in-situ test results and prevent the valve from performing its design function. 2 refs., 12 figs., 2 tabs.

21835 (NUREG/CP–0097-Vol.3, pp. 519-546) **Initial assessment of the processes and significance of thermal aging in cast stainless steels.** Chopra, O.K. (Argonne National Lab., IL (USA)); Chung, H.M. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

Charpy-impact and J-R curve data for thermally aged cast stainless steel are presented. The effects of material variables on the embrittlement of cast materials are evaluated. The chemical composition and ferrite morphology have a strong effect on the kinetics and extent of embrittlement. The procedure and correlations for predicting the impact strength and fracture toughness of cast components during reactor service are described. 19 refs., 17 refs., 4 tabs.

21836 (NUREG/CP–0097-Vol.3, pp. 547-562) **Shippingport aging studies - results and plans.** Shack, W.J. (Argonne National Lab., IL (USA)); Chopra, O.K.; Chung, H.M.; Rosinski, S.T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.3: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct

1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 3, Nuclear plant aging, structural and seismic engineering, mechanical research, environmental effects in primary systems.* Order Number DE89010313. Available from NTIS, PC A24/MF A01 - I.

This paper describes the materials obtained from the primary- and secondary-coolant systems and the neutron shield tank of the Shippingport reactor and the initial work done to characterize the materials. The samples from the primary- and secondary-coolant systems include primary coolant system valves, sections of a coolant pipe, a main steam pipe, a feedwater pipe, an instrument pipe, a purification pipe, and a fuel pool pipe; and two cast pump volutes. Eleven samples, approximately 6 in. in diameter were obtained from the inner wall of the shield tank along with the corresponding samples from the very slightly irradiated outer wall. Test plans and initial Charpy-impact test data for the shield tank material are presented. Although large uncertainties exist at present, the preliminary results suggest that the changes in transition temperature are not as sever as might be expected on the basis of the changes observed in HFIR. However, the actual value of the transition temperature is high, and the toughness at service temperature is low, even when compared with the HFIR data. The chemical composition, hardness, and the amount and distribution of ferrite for the cast materials obtained from Shippingport are described. All materials are CF-8-grade cast stainless steel. Examination of specimens from the valves by transmission electron microscopy (TEM) showed very finely scaled mottle images ($\approx$ 1-2 nm) in the ferrite, which are known to be characteristic of α' prime formation by spinodal decomposition. G phase was also observed in the ferrite. These observations are consistent with studies on laboratory-aged materials. 6 refs., 11 figs., 6 tabs.

21837 (NUREG/CR–4659-Vol.3) **Seismic fragility of nuclear power plant components (Phase II): Volume 3, Switchgear, I and C panels (NSSS) and relays.** Bandyopadhyay, K.K. (Brookhaven National Lab., Upton, NY (USA)); Hofmayer, C.H.; Kassir, M.K.; Pepper, S.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Feb 1990. 69p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52007-Vol.3). Available from NTIS, PC A04/MF A01 - GPO - OSTI.

As part of the Component Fragility Program which was initiated in FY 1985, three additional equipment classes have been evaluated. This report contains the fragility results and discussions on these equipment classes which are switchgear, I and C panels and relays. Both low and medium voltage switchgear assemblies have been considered and a separate fragility estimate for each type is provided. Test data on cabinets from the nuclear instrumentation/neutron monitoring system, plant/process protection system, solid state protective system and engineered safeguards test system comprise the BNL data base for I and C panels (NSSS). Fragility levels have been determined for various failure modes of switchgear and I&C panels, and the deterministic results are presented in terms of test response spectra. In addition, the test data have been evaluated for estimating the respective probabilistic fragility levels which are expressed in terms of a median value, an uncertainty coefficient, a randomness coefficient and an HCLPF value. Due to a wide variation of relay design and the fragility level, a generic fragility level cannot be established for relays. 7 refs., 13 figs., 12 tabs.

21838 (NUREG/CR–4661) **Closeout of IE Bulletin 85-03: Motor-operated valve common mode failures during plant transients due to improper switch settings.** Foley, W.J. (Parameter, Inc., Elm Grove, WI (USA)); Dean, R.S.; Steinbrecher, D.H.; Hennick, A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Operational Events Assessment; Parameter, Inc., Elm Grove, WI (USA). Feb 1990. 106p. Sponsored by Nuclear Regulatory Commission. (PARAMETER/IE–158). Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

Documentation is provided in this report for the closeout of IE Bulletin 85-03. The purpose of the bulletin was to request licensees to develop and implement programs to ensure that the switch settings on certain safety-related, motor-operated valves are selected, set, and maintained so as to ensure reliable valve operation when valves are subjected to maximum differential pressures expected during normal operation and the design basis events. The report includes documentation and status of the review of Action Item e of the bulletin completed up to the issuance of Generic Letter 89-10 on June 28, 1989. Licensee actions for Action Item e were completed satisfactorily for 102 (86%) of the 119 facilities for which actions were required. Satisfactory completion of the remaining 17 facilities is ensured by the generic letter. In the report conclusions, the inter-relationship of the generic letter and the bulletin is presented. Background information is supplied in the Introduction and Appendix A.

21839 (NUREG/CR–4667-Vol.7) **Environmentally assisted cracking in light water reactors: Semiannual report, April 1988–September 1988: Volume 7.** Shack, W.J. (Argonne National Lab., IL (USA)); Kassner, T.F.; Park, J.Y.; Ruther, W.E.; Soppet, W.K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Argonne National Lab., IL (USA). Mar 1990. 48p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. (ANL–89/40-Vol.7). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This report summarizes work performed by Argonne National Laboratory on environmentally assisted cracking in light water reactors during the six months from April to September 1988. The stress corrosion cracking (SCC) of Types 316NG and 304 stainless steels (SSs) was investigated by means of slow-strain-rate and fracture-mechanics crack-growth-rate tests in high-temperature water. The effects of load ratio and water chemistry on the crack growth behavior of Type 316NG and sensitized Type 304 SS were determined in long-term fracture-mechanics tests. The influence of organic impurities on the SCC of sensitized Type 304 SS was also investigated. Fatigue tests were conducted on Type 316NG SS in air and simulated boiling water reactor water at 288°C to assess the degree of conservatism in the ASME Code Section III fatigue design curves. An ongoing investigation of the susceptibility of several heats of different grades of low-alloy ferritic steels to transgranular SCC in slow-strain-rate and fracture-mechanics tests was continued. 58 refs., 18 figs., 14 tabs.

21840 (NUREG/CR–4674-Vol.10) **Precursors to potential severe core damage accidents: 1988 a status report: Appendixes B and C.** Minarick, J.W. (Oak Ridge National Lab., TN (USA)); Cletcher, J.W.; Blake, A.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Programs; Oak Ridge National Lab., TN (USA). Feb 1990. 471p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/NOAC–232-Vol.10). Available from NTIS, PC A20/MF A01 - GPO; OSTI; INIS.

Thirty-two operational events with conditional probabilities of core damage of 1.0×10^{-6} or higher occurring at commercial light-water reactors during 1988 are considered to be precursors to potential severe core damage. These are described along with associated significance estimates, categorization, and subsequent analyses. This study is a continuation of earlier work, which evaluated the 1969–1981 and 1984–1987 events. The report discusses (1) the general rationale for this study, (2) the selection and documentation of events as precursors, (3) the estimation and use of conditional probabilities of subsequent severe core damage to rank precursor events, and (4) the plant models used in the evaluation process. This document, Volume 10, provides appendices B and C of this report. 2 tabs.

21841 (NUREG/CR–5229-Vol.2) **TMI-2 EPICOR-II Resin/Liner Investigation: Low-level waste data base development program for fiscal year 1989: Annual report.** McConnell, J.W. Jr. (Oak Ridge National Lab., TN (USA)); Rogers, R.D.; Davis, E.C.; Jastrow, J.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Idaho National Engineering Lab., Idaho Falls, ID (USA); EG and G Idaho, Inc., Idaho Falls, ID (USA); Oak Ridge National Lab., TN (USA); Argonne National Lab., IL (USA). Feb 1990. 49p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2577-Vol.2). Available from NTIS, PC A03/MF A01; OSTI; INIS.

The TMI-2 EPICOR-II Resin/Liner Investigation: Low-Level Waste Data Base Development Program is funded by the US Nuclear Regulatory Commission (NRC). The purpose of this program is to: (a) study the degradation effects in EPICOR-II organic ion exchange resins caused by radiation (resin degradation), (b) examine the adequacy of test requirements of 10 CFR 61, using waste forms containing solidified EPICOR-II resins (resin solidification), (c) obtain performance information on solidified EPICOR-II ion exchange resins in a disposal environment (field testing), (d) determine the condition of EPICOR-II liners (liner integrity examination). This report summarizes accomplishments of Fiscal Year 1989. The third sampling of ion exchange resins from EPICOR-II prefilters PF-8 and -20, to determine degradation, is described. Results of the fourth year of data acquisition from the field testing are presented and discussed. During the continuing field testing, both Portland Type I-II cement and Dow vinyl esterstyrene waste forms are being tested in lysimeter arrays located at Argonne National Laboratory in Illinois (ANL-E) and Oak Ridge National Laboratory (ORNL). The study is designed to provide continuous data on nuclide release and movement, as well as environmental conditions, over a 20-year period. All work in the liner integrity examination studies was completed in FY-1984. 17 refs., 42 figs., 12 tabs.

21842 (NUREG/CR–5273-Vol.4) **SCDAP/RELAP5/MOD2 code manual: Volume 4, MATPRO: A library of materials properties for light-water-reactor accident analysis.** Hohorst, J.K. (ed.) (EG and G Idaho, Inc., Idaho Falls, ID (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 1098p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2555-Vol.4). Available from NTIS, PC A99/MF A01 - GPO; OSTI; INIS.

This report describes the materials properties correlations and computer subcodes (MATPRO) developed for use with various light water reactor (LWR) accident analysis computer programs. Formulation of the materials properties are generally semiempirical in nature. The materials properties subcodes contained in this document are for uranium, uranium dioxide, mixed uranium-plutonium dioxide fuel, zircaloy cladding, zirconium dioxide, stainless steel, stainless steel oxide, silver-indium-cadmium alloy, boron carbide, Inconel 718, zirconium-uranium-oxygen melts, and fill gas mixtures. 452 refs., 230 figs., 139 tabs.

21843 (NUREG/CR–5286) **Closeout of IE Bulletin 79-17: Pipe cracks in stagnant borated water systems at PWR [pressurized water reactors] plants.** Foley, W.J.; Dean, R.S.; Hennick, A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Operational Assessment; Parameter, Inc., Elm Grove, WI (USA). Feb 1990. 30p. Sponsored by Nuclear Regulatory Commission. (PARAMETER/IE–177). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Documentation is provided in this report for the closeout of IE Bulletin 79-17 and its revision on the safety-related subject of pipe cracks in stagnant borated water systems at operating plants with pressurized water reactors (PWRs). Closeout is based on the implementation and verification of actions required by the bulletin. Evaluation of utility responses and NRC/Region inspection reports indicates that the bulletin is closed for all of the 41 operating PWRs to which it was issued for action. It is concluded that the concerns of the bulletin have been resolved. Background information is supplied in the Introduction and Appendix A.

21844 (NUREG/CR–5302) **Closeout of IE Bulletin 80-10: Contamination of nonradioactive system and resulting potential for unmonitored, uncontrolled release of radioactivity to the environment.** Foley, W.J. (Parameter, Inc., Elm Grove, WI (USA)); Dean, R.S.; Hennick, D.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Operational Events Assessment; Parameter, Inc., Elm Grove, WI (USA). Feb 1990. 28p. Sponsored by Nuclear Regulatory Commission. (PARAMETER/IE–193). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Documentation is provided in this report for the closeout of IE Bulletin 80-10 regarding contamination of nonradioactive systems resulting in the potential for unmonitored, uncontrolled release of radioactivity to the environment. Closeout is based on the documentation and verification of four actions required by the bulletin for holders of an operating license for a nuclear power facility at the time the bulletin was issued (05-06-80). The bulletin was issued for information to holders of a construction permit for a nuclear power facility. Evaluation of utility responses and NRC/Region inspection reports in accordance with the closeout criterion indicates that the bulletin is closed for 65 (98%) of the 66 nuclear power facilities to which it was issued for action. A follow-up item is proposed for the facility with open status, for the use of NRC regional inspectors in ensuring successful completion of required actions. When the bulletin is closed as anticipated for the facility which requires follow-up (see page C-1), the concerns of the bulletin will have been resolved completely. Background information is supplied in the Introduction and Appendix A.

21845 (NUREG/CR–5316) **Melt progression, oxidation, and natural convection in a severely damaged reactor core.** Dosanjh, S.S. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 87p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–88-3476). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

In the revised Severe Accident Research Program plan recently issued by the US Nuclear Regulatory Commission, it was noted that the initial phases of hypothetical reactor accidents have received the greatest attention. Much less research has focused on late phase melt progression. This report describes a model that treats some of the physical processes that can occur in a severely degraded reactor core. Of interest here are melt progression, oxidation, and gas phase natural convection. A number of sensitivity analyses are also discussed to help identify the most important parameters in the model. 106 refs., 33 figs., 1 tab.

21846 (NUREG/CR–5376) **Quality assurance and verification of the MACCS [MELCOR Accident Consequence Code System] code, Version 1.5.** Dobbe, C.A. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Carlson, E.R.; Marshall, N.H.; Marwil, E.S.; Tolli, J.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 50p. Sponsored by Nuclear Regulatory Commission. (EGG–2566). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

An independent quality assurance (QA) and verification of Version 1.5 of the MELCOR Accident Consequence Code System (MACCS) was performed. The QA and verification involved examination of the code and associated documentation for consistent and correct implementation of the models in an error-free FORTRAN computer code. The QA and verification was not intended to determine either the adequacy or appropriateness of the models that are used MACCS 1.5. The reviews uncovered errors which were fixed by the SNL MACCS code development staff prior to the release of MACCS 1.5. Some difficulties related to documentation improvement and code restructuring are also presented. The QA and verification process concluded that Version 1.5 of the MACCS code, within the scope and limitations process concluded that Version 1.5 of the MACCS code, within the scope and limitations of the models implemented in the code is essentially error free and ready for widespread use. 15 refs., 11 tabs.

21847 (NUREG/CR–5405) **Analysis of shell-rupture failure due to hypothetical elevated- temperature pressurization of the Sequoyah Unit 1 steel containment building.** Miller, J.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 88p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-1650). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Sandia National Laboratories, as part of the Containment Integrity Programs under the sponsorship of the Nuclear Regulatory Commission (NRC), has developed analytical techniques for predicting the performance of light water reactor steel containment buildings subject to loads beyond the design basis. The analytical techniques are based on experience with large-scale steel containment model tests that provided important insights and experimental validation of the analytical methods. As a means of demonstrating these analytical techniques, the NRC asked Sandia to conduct a

structural evaluation of an actual steel containment building. The objective of the analysis was to determine the actual pressure capacity and the mode, location, and size of failure, where a functional definition of failure is used. The purpose of this report is to document the calculations performed to determine the pressure limits for the shell- rupture mode of failure. General failure of the containment shell is predicted by application of a failure criterion to the results from finite element structural analyses. The failure criterion relates the calculated values of strain in the containment plates, due to internal-pressurization loading, to the ultimate strain limit of the steel. Included in the failure criterion are adjustments for factors inherent in finite element analysis, such as level of detail and element size of the finite element model and variations in material property data. Separate finite element models were used to evaluate the overall free-field behavior of the structure and the localized behavior at a specific penetration location. 18 refs., 68 figs., 10 tabs.

21848 (NUREG/CR–5476) **Posttest analysis of a 1:6-scale reinforced concrete reactor containment building.** Weatherby, J.R. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 82p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-2603). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

In an experiment conducted at Sandia National Laboratories, 1:6-scale model of a reinforced concrete light water reactor containment building was pressurized with nitrogen gas to more than three times its design pressure. The pressurization produced one large tear and several smaller tears in the steel liner plate that functioned as the primary pneumatic seal for the structure. The data collected from the overpressurization test have been used to evaluate and further refine methods of structural analysis that can be used to predict the performance of containment buildings under conditions produced by a severe accident. This report describes posttest finite element analyses of the 1:6-scale model tests and compares pretest predictions of the structural response to the experimental results. Strain and displacements calculated in axisymmetric finite element analyses of the 1:6-scale model are compared to strains and displacement measured in the experiment. Detailed analyses of the liner plate are also described in the report. The region of the liner surrounding the large tear was analyzed using two different two-dimensional finite elements model. The results from these analyzed indicate that the primary mechanisms that initiated the tear can be captured in a two- dimensional finite element model. Furthermore, the analyses show that studs used to anchor the liner to the concrete wall, played an important role in initiating the liner tear. Three-dimensional finite element analyses of liner plates loaded by studs are also presented. Results from the three-dimensional analyses are compared to results from two-dimensional analyses of the same problems. 12 refs., 56 figs., 1 tab.

21849 (NUREG/CR–5479) **Current applications of vibration monitoring and neutron noise analysis: Detection and diagnosis of structural degradation of reactor vessel internals resulting from operational aging.** Damiano, B. (Oak Ridge National Lab., TN (USA)); Kryter, R.C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Feb 1990. 31p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11398). Available from NTIS, PC A03/MF A01 - GPO - OSTI.

Monitoring programs using vibration monitoring or neutron noise analysis have demonstrated the ability to detect and, in some cases, diagnose the nature of reactor vessel internals structural degradation. Detection of compromised mechanical integrity of reactor vessel internal components in its early stages allows corrective action to be taken before weakening or damage occurs. In addition to the economic benefits early detection and correction can provide, they can also help maintain plant safety. Information on the condition of reactor vessel internal components gained from a monitoring program supplements in-service inspection results and may be useful in justifying plant license extension. This report, which was prepared under the Nuclear Plant Aging Research Program sponsored by the US Nuclear Regulatory Commission, discusses the application of vibration monitoring and neutron noise analysis for monitoring light-water reactor vessel internals. The report begins by describing the effects of structural integrity loss on internals vibration and how measurable parameters can be used to detect and track the progress of degradation. This is followed by a description and comparison of vibration monitoring and neutron noise analysis, two methods for monitoring the mechanical integrity of reactor vessel internals condition monitoring programs in the United States, Federal Republic of Germany, and France, three countries having substantial commitments to nuclear power. The last section presents guidelines for US utilities wishing to establish reactor internals condition monitoring programs. 20 refs., 5 figs., 4 tabs.

21850 (SAND–88-1465) **An exploratory sensitivity study with the MACCS [MELCOR Accident Consequence Code System] Reactor Accident Consequence Model.** Helton, J.C. (Arizona State Univ., Tempe, AZ (USA). Dept. of Mathematics); Rollstin, J.A; Sprung, J.L.; Johnson, J.D. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 70p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90007614. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

An exploratory sensitivity study with the MELCOR Accident Consequence Code System (MACCS) is presented. This study was performed to provide (1) an indication of the possible impact of consequence modeling uncertainties on the results of an integrated probabilistic risk assessment for a nuclear power station, (2) guidance on important parameters to direct data acquisition for future uncertainty analyses with MACCS, (3) a check that MACCS is indeed operating as intended, and (4) insights on the effect of problem gridding on model resolution. The following consequence measures were investigated: early fatalities, prodromal vomiting, lung impairment, population dose (0 to 500 mi), population dose (0 to 10 mi), mean early fatality distance, maximum early fatality distance, mean early fatality risk, probability of one or more early fatalities, and amount of central processing unit (CPU) time required to evaluate MACCS. The analysis used techniques based on Latin hypercube sampling and regression analysis. 106 refs., 21 tabs.

21851 (YJT–89-12) **Activity inventory of the activated decommissioning waste in the Olkiluoto nuclear power plant.** Anttila, M. (Technical Research Centre of Finland, Helsinki. Nuclear Engineering Laboratory (Finland)); Wasastjerna, F. Voimayhtioeiden Ydinjaetetoimikunta, Helsinki (Finland). Sep 1989. 58p. Order Number DE90620393. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Radioactive properties of the decommissioning waste components outside the active cores of two nuclear reactors in the Olkiluoto Power Plant have been studied. The radial and axial flux distributions corresponding to the average irradiation conditions have been calculated with a new version of VTT's REPVICS program system applying a one-dimensional approximation (the ANISN computer code). Using the new flux and flux ratio values the activation and subsequent cooling of the components have been analyzed with the ORIGEN-S computer program. In the radial direction the calculation area has been extended to the outer surface of the biological shield. In a separate technical report (TVO/VLJ Repository, Technical report 89-05) the input data and results of the flux calculations have been described. In this report the corresponding data of the ORIGEN-S calculations, e.g. the nuclide-wise and total activity and the photon spectrum of each component as a function of cooling time, have been preseted. The total activity inventory of the components has been estimated in quite an approximate way, too.

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Refer also to citation(s) 21913

21852 (CRIE-W-88029) **Characteristics of metal oxide surge arrester elements under water absorption.** Izumi, Kunikazu; Ito, Hideo; Taniguchi, Takeshi. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1989. 32p. (In Japanese). Order Number DE90753098. Available from NTIS (US Sales Only), PC A03/MF A01.

Since the metal oxide elements (capacitance of switching surge operation duty test : 25 μF) which are used for the metal oxide surge arrester are polycrystals sintered compact, it is thought that characteristics of the elements are affected by water absorption or moisture absorption when the airtightness of seal of the surge arrester is lowered. The thermal stability and the characteristics of the metal oxide elements under water absorption and the detection method for the water absorption in the elements, were studied. The element voltages in the small current region under water absorption are about 80% of those on new elements. However, a change of the lightning impulse residual voltages and a lowering of the lightning impulse high current capabilities, were not observed. From the results of the thermal stability analysis for the water absorbed element with the required energy dissipation, it is considered that the thermal runaway will not occur in the case of the voltage application factor of 50%. As the detection method for the water absorption in the elements, a judgment based on the change of the voltage or the electrical conductivity of elements in the small current region is effective measures. 11 refs., 24 figs., 1 tab.

2401 Power Systems

21853 (BCH-90-00631) **Proposal for the Fraser Valley substation and Puget Sound power and light intertie study.** British Columbia Hydro, Vancouver, BC (Canada). Oct 1989. 12p. (MICROLOG-90-00631). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

B.C. Hydro presently operates a high voltage transmission line corridor running generally through the Fraser Valley. The corridor has 2,500kV transmission lines and one 230kV line, with the 230kV line supplying the Fraser Valley. This corridor could be affected by 2 related concerns: the need for a new 500-230kV transformer substation to meet the growing demand for electricity in the central Fraser Valley; and a proposal by Puget Sound Power and Light Company of Bellevue, Washington, for a new transmission intertie connecting the 2 systems across the U.S./Canada border. This summary gives the rationale for the project, the regulatory approvals needed, a description of the study being done on both aspects of the project, route planning, a study schedule, and the public consultation program.

21854 (BCH-90-0638) **A prospectus for the Kelly Lake Substation to Cheekye Substation second 500 kV transmission line.** British Columbia Hydro, Vancouver, BC (Canada). Sep 1989. 11p. (MICROLOG-90-00638). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Recent forecasts of electrical demand in the Lower Mainland and on Vancouver Island, combined with engineering studies of the electrical transmission system, have identified a potential requirement for new transmission in the mid-1990s. This prospectus outlines B.C. Hydro's studies for a second 500kV transmission line between Kelly Lake Substation near Clinton and Cheekye Substation near Squamish. The prospectus includes a brief description of the project and a schedule for meeting an in-service date as early as the fall of 1995; a summary of the rationale for carrying out studies for a second Kelly Lake to Cheekye 500kV line; and an outline of the studies planned to determine a route for the line, including a comprehensive public consultation program. 5 figs.,

21855 (BCH-SP8905) **The Third Williston to Kelly Lake 500 kv transition line: Project rationale.** British Columbia Hydro, Vancouver, BC (Canada). Nov 1989. 24p. (MICROLOG-90-00639). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report outlines B.C. Hydro's planning process for major transmission projects and explains how that process led to the proposal to reinforce the Williston to Kelly Lake transmission system with a third 500kV single circuit transmission line between those substations. The report contains brief descriptions of a typical electrical transmission system; B.C. Hydro's existing major transmission system; the electric load forecast for the next 10 years; the resource plan to meet the growing electric load; the transmission planning process which determines what system reinforcement is needed; and the third Williston to Kelly Lake 500kV transmission line. A glossary of terms is included.

21856 (DOE/BP/35389-T1) **Trend analysis: Performance monitoring of transformers: Final report: Volume 1.** Cooke, C.M.; Melcher, J.R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Oct 1988. 364p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG79-87BP35389. Order Number DE90008477. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

The Massachusetts Institute of Technology, Laboratory for Electromagnetic and Electronic Systems, has completed a four-year research program to develop advanced technologies for improved reliable monitoring to detect hazardous internal conditions in large power transformers while in service. This project has been coordinated by the MIT Electric Utility Program and sponsored by a group of eight electric utility companies and ESEERCO. This report documents the technical activities during the four year program which formally began July 1, 1984. The motivation for the work has been that successful monitoring will lead to increased power system reliability and important economic benefits. A significant reduction in failure rate of large transformers and the potential improvement in their operation and maintenance are goals of the work. The program has resulted in the development of a working pilot monitoring system, operating on a small transformer at MIT. This system incorporates many findings and research developments on (1) improved sensing devices and sensing systems, (2) new analytical structures which evaluate the status of the transformer relative to normal behavior, and (3) new computer operating system hardware and codes which provide complete control and flexible reporting of the monitoring process.

21857 (N-90-13596) **The US space station and its electric power system.** Thomas, R.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1988. 26p. (NASA-TM-101974;E-4674;NAS-1.15:101974;CONF-8805361-: 10. South Pacific electrical international convention, Brisbane (Australia), 2-5 May 1988). Available from NTIS, PC A03/MF A01.

The United States has embarked on a major development program to have a space station operating in low earth orbit by the mid-1990s. This endeavor draws on the talents of NASA and most of the aerospace firms in the U.S. Plans are being pursued to include the participation of Canada, Japan, and the European Space Agency in the space station. From the start of the program these was a focus on the utilization of the space station for science, technology, and commercial endeavors. These requirements were utilized in the design of the station and manifest themselves in: pressurized volume; crew time; power availability and level of power; external payload accommodations; microgravity levels; servicing facilities; and the ability to grow and evolve the space station to meet future needs. President Reagan directed NASA to develop a permanently manned space station in his 1984 State of the Union message. Since then the definition phase was completed and the development phase initiated. A major subsystem of the space station is its 75 kW electric power system. The electric power system has characteristics similar to those of terrestrial power systems. Routine maintenance and replacement of failed equipment must be accomplished safely and easily and in a minimum time while providing reliable power to users. Because of the

very high value placed on crew time it is essential that the power system operate in an autonomous mode to minimize crew time required. The power system design must also easily accommodate growth as the power demands by users are expected to grow. An overview of the U.S. space station is provided with special emphasis on its electrical power system.

21858 **Response of helical structures to high speed pulses: Or when can a helix be called an inductor.** . DiCapua, M.S. (Lawrence Livermore National Lab., CA (USA)); Molau, N.E.; Wheeler, P.C. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract W-7405-ENG-48. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Vacuum and dielectric cored loosely wound helices are widely used in pulse power systems. In one extreme, when the applied pulse length is shorter than the transit time in the helix, helices are used as transit time isolators, to lead signals from high voltage terminals to ground. In the other extreme, for pulse durations that are much longer than the transit time, helices act as conventional inductors and are used for high frequency isolation or as shields for trigger, signal or gas leads to pulse power components. In either case, the use of helices in the presence of fast pulses requires an understanding of their behavior in regimes where time delays associated with wave propagation in the helix are not negligible when compared to the length or risetime of the applied pulse and hence their description as lumped elements is no longer current. This paper describes the results of analytical approximations, circuit simulations, 3-D time dependent electromagnetic modeling as well as laboratory measurements on helices surrounded by conducting structures. On the basis of these investigations their suitability as voltage measuring devices is discussed.

21859 **Development of a repetitive 1-MV, 22-kJ Marx generator.** O'Malley, M.W. (Sandia National Labs., Albuquerque, NM (USA)); Buttram, M.T. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

A 220-kW Marx generator has been designed, built, and tested. It was developed to drive several different pulse power experimental devices requiring repetitive pulses at voltages to 1 MV and energies to 22 kJ per pulse. Experiments are planned that will explore dielectric performance under repetitive stress, cold cathode diode operation, and repetitive switching with saturable inductors at moderate peak power and voltage. A Marx generator was chosen because it has the versatility to drive such a variety of loads. The Marx generator system is made of 16 inductively isolated capacitor stages resistively charged to a maximum of 62.5 kV per capacitor and eight gas dynamic spark gaps. The charging source is a 2-MW dc bipolar power supply. The gas purging system is capable of supplying 3500 SCFH of air at the required pressure. The first two spark gaps of the Marx generator are triggered with a grounded grid thyratron pulser through a 1:10 step-up transformer with an output peaking gap as an (unused) option. At the maximum output (1 MV, 22 kJ) a repetition rate of 10 Hz is possible. This paper reviews some of the development work done on rep rated Marx generators as well as explains the present Marx generator configuration and associated hardware systems.

21860 **Operation of the TEMPO machine.** Rohwein, G.J. (Sandia National Labs., Albuquerque, NM (USA)); Lawson, R.N.; Lancaster, K.T. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The TEMPO machine is a repetitively pulsed, high-voltage driver for experimental microwave generating devices. Three units have been built. TEMPO has a transformer-charged, water-insulated Blumlein directly coupled to the vacuum diode. The Blumlein has a relatively high impedance strip-type, pulse-forming transmission line (PFL) designed to minimize size. Stray capacitance and enhanced electric fields along the edges of the PFL are controlled by lining the tank in which the Blumlein is housed with polyvinyl chloride (PVC) plastic sheet. During the initial stage of operation, problems with breakdowns in the plastic occurred that necessitated replacing the liner with either polyethylene or polypropylene. During the same period, problems with the power supplies and high voltage switch performance were addressed. These modifications and their results are discussed.

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 21937, 22344

21861 (CRIE-W–88023) **Development of instantaneous removal device for short-circuit fault in low voltage distribution lines.** Sekiguchi, Terukazu. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1989. 35p. (In Japanese). Order Number DE90753094. Available from NTIS (US Sales Only), PC A03/MF A01.

Since the low voltage distribution lines are studied to raise the voltag to 200/400v, it is necessary to make the operation of protective devices such as low voltage fuse, and etc, more firmly to ensure the safety. Therefore, a bypass device inserted to low voltage fuse side at a service branch point was devised as a fault removal method which could be made without any change of present circuit breaker or low voltage fuse, mainly on the system from branch point of low voltage distribution lines to the service entrance for a general user. The operation of this device utilizes the electromagnetic force generated by the short-circuit current itself. The device consists of two parallel conductors, by which the electromagnetic force generates when short-circuit current flows in it, and when this current overcomes the spring resistance, the bypass contact is connected to from a circuit compulsorily and to greatly make shunt current to the fault point flowing. the main characteristics are as follows; average displacement speed of 50cm/s and maximum displacement of 18mm. 5 refs., 19 figs., 2 tabs.

21862 (CRIE-W–88024) **Improvement of the insulation near the interface to semiconducting layer on EHV XLPE cables by an additive.** Ishida, Masayoshi; Okamoto, Tatsuki; Hozumi, Naohiro. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1989. 41p. (In Japanese). Order Number DE90753095. Available from NTIS (US Sales Only), PC A03/MF A01.

To reduce by half the insulation thickness of EHV XLPE cables, it has been developed a method for improving the electrical insulation breakdown strength through mixing an additive into the semiconducting layer. In order to study morphological effects of the polyethylene insulation by diffused additive, the insulation mixed directly the additive was prepared, then the material properties and the dielectric breakdown characteristics at various additive-concentrations were analyzed. As the results, it was analyzed that the density of the amorphous portion, the lamella thickness and the spherulite radius are increased with adding concentration, and the properties and characteristics are improved. It was also suggested that the possibility of stable performance on long term utility is expected by fixing XLPE superstructure. It is found that the mean breakdown strength is improved by direct mixing the additive, however the breakdown strength at low probability is not improved because of occuring micro-lamps of undiffused additive. It is confirmed that proposed additive-diffusing method is effective measures for improving the breakdown strength in application to cables. 13 refs., 29 figs., 1 tab.

21863 (CRIE-W–88039) **Dependence of the breakdown strength on the lamella orientation at the semiconducting interface in improved XLPE power cables.** Okamoto, Tatsuki; Ishida, Masayoshi; Hozumi, Naohiro. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1989. 36p. (In Japanese). Order Number DE90753100. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to reduce the construction cost of underground power cables, an extra-high voltage CV cable reduced by half the insulation thickness is being developed. As a developing procedure, interfacial diffusion method in which additives were added to the semiconducting layer and were diffused in the insulation, was developed, and the effects of additives on the lamella orientation and the insulation breakdown strength were examined. As a result, it was found that there was an anisotropy in the lamella orientation at the semiconducting interface in cables. As the result of measurements of the averaged lamella angle θ_1 in the transverse cross-section and the averaged lamella angle θ_2 in the cross-section along a specimen, it was elucidated that θ_1 was larger than θ_2 and there was the anisotropy in the lamella orientation. It was also found that the impulse breakdown strength increases as the difference between θ_1 and θ_2 decreases. Not only a disc specimen with thin insulation thickness but also a cable specimen with thick insulation thickness is improved in the lamella orientation by additives and is also improved in the breakdown strength. 8 refs., 21 figs., 3 tabs.

21864 (ECRC/R–2354) **Basics of distribution system ferroresonance.** Aubrey, D.R. Electricity Council Research Centre, Capenhurst (UK). Aug 1989. 30p. Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK. Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.

UK distribution systems do not suffer many problems with ferroresonance, but they do occur from time to time. Ferroresonance is not a text book subject, and those who may be confronted with it when dealing with a specific problem can be faced with the time consuming task of identifying suitable references. As assistance with that task, this report contains a bibliography and an overview of distribution ferroresonance with additional mention of factors to be considered so that future major system design changes will not increase the likelihood of ferroresonant events. (author).

21865 (OH/RD–89-216-K) **Ferroresonance tests on T14 tertiary at Claireville TS [transmission station].** Cheung, R.W. (Ontario Hydro, Toronto, ON (Canada)). Ontario Hydro Research Div., Toronto, ON (Canada). 1 Sep 1989. 14p. (MICROLOG–90-00422). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A series of full-scale switching operations was performed on the T14 autotransformer at Claireville transformer station. These operations were intended to duplicate a reported ferroresonance condition on T14 28-kV tertiary; however, results show that ferroresonance was not established. Analysis of test results shows that potential transformer remanence after switching T14 off-potential was not sufficient to initiate a ferroresonance condition on the subsequent closing operation. Such a condition which requires a high potential transformer remanence and a particular pole-closing sequence on subsequent energization is not a very likely occurrence. However, in view of the fact that ferroresonance has been encountered before and its possibility cannot be ruled out, a solution of a resistor connected across the potential transformer secondary is proposed. 7 refs., 7 figs., 1 tab.

21866 Characterization of surface discharge switches and high performance applications. Reinovsky, R.E. (Los Alamos National Lab., NM (USA)); Goforth, J.H.; Greene, A.E.; Graham, J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Results of experiments which were conducted to characterize the performance of a surface discharge as a high-performance, self-closing isolation switch for high energy applications are described. These experiments, conducted under both DC and pulsed conditions, lead to a model of switch operation which enables the design of such switches for multi-megajoule operation. The paper describes the successful implementation of a surface switch as an operational component in a multi-megampere pulse-power system.

2403 Power Transmission Lines and Cables

21867 (ECRC/M–2433) **Recent performance on testing and service performance of polymeric insulated cables in wet environments.** Naybour, R.D.; Price, D.J. Electricity Council Research Centre, Capenhurst (UK). Nov 1989. 8p. Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK. Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.

Two water tree resistant and one conventional cross-linked polyethylene insulated 11 kV cables have been aged for times up to 16,000 hours in hot water. The breakdown strengths after ageing have been assessed over the voltage range 50 to 20 kV. The water tree resistant material is less deteriorated than the conventional insulation. These results are compared to similar tests on a cable which failed in service as a result of water tree growth. (author).

21868 (ECRC/R–2393) **Interpretation of discharges in paper-insulated cables.** Robinson, G. Electricity Council Research Centre, Capenhurst (UK). Dec 1989. 53p. Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK. Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.

Describes the results of experimental and theoretical investigations into the significance and interpretation of sequences of discharges which occur in paper insulation under high alternating stresses. The work is intended to assist in the development of methods of estimating the failure probability of paper-insulated underground cables. The principal conclusion of the work is that when one face of a discharging cavity is bounded by a metal (as it is at the screen or the conductor of a cable), the discharge sequence is well described by a model based on the statistics of random events. This model provides a less arbitrary interpretation of the discharge spectrum than earlier models and describes observed size distributions more closely. In particular, both theory and experiment suggest that although one face of the cavity is an insulator, a small proportion of discharges correspond to full discharge of the capacitor represented by the cavity. This result is significant because it shows that the size of the largest measured discharge can be predicted for given cavity dimensions. This report presents calculated values of discharge size and energy for the cavities that are expected to be present in 11 kV and 33 kV cables. (author).

21869 (OH/RD–89-31-K) **Electrical conductivity of insulator surface ices.** Buchan, P.G. (Ontario Hydro, Toronto, ON (Canada)). Ontario Hydro Research Div., Toronto, ON (Canada). 10 May 1989. 17p. (MICROLOG–90-00419). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

Hot and cold fog testing of artificially contaminated and iced insulators requires careful attention to the conductivity of the water supply. Investigations have shown that even the conductivity of the surface ice can vary, especially between that on the upper surface and the icicles that form on the lip. These observations led to a series of investigative experiments which include a study of ice conductivities at temperatures below freezing and a study of the conductivity of the melt water. This report deals mainly with these physical charcteristics and makes no attempt to explain the behaviour of iced and contaminated insulators from the measured data. The electrical conductivity of ice fragments removed from artificially contaminated and iced insulators was measured in the laboratory. Icicle-tips and other bottom surface pieces that freeze last were frequently found to have conductivities two to three times greater than the upper portions of ice that freeze first. An explanation of this phenomenon was found in crystallization theory, but its importance in the flashover process of contaminated and iced insulators has not been established. It was recommended that, when making artificial rain with demineralized water for experimental testing of insulators, the conductivity should be closely matched to natural rain. 2 refs., 7 figs., 2 tabs.

21870 (OH/RD–89-79-K) **Transmission line refurbishment study: Tests on Kingston type steel transmission towers. Smith Falls.** Krishnasamy, S.G. Ontario Hydro Research Div.,

Toronto, ON (Canada). 27 Jun 1989. 85p. (MICROLOG–90-01177). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A comprehensive program was initiated by Ontario Hydro to study the condition of existing older overhead transmission lines and to assess the condition and remaining life of conductors, hardware, insulators, structures and foundations. As part of the ongoing transmission line refurbishment study, 3 single circuit 115 kV, Kingston type suspension towers on rock-anchor foundations were tested to failure. The type of loads applied on the towers were chosen to represent unbalanced loads due to broken skywire and conductor, heavy ice, strong wind and wind-on-ice loads. Selected tower members and foundations were instrumented to measure the member loads, tower deflections and foundation movement during various stages of testing. The measured values were compared with the corresponding predicted values. The correlation is good between the predicted and actual tower failure loads. The tower tests confirmed that there is reserve strength available for upgrading the conductor on this line. The measured tower member loads and foundation loads correlated fairly satisfactorily with the corresponding calculated values. The rock-anchor foundation did not show any movement at all. 38 figs., 18 tabs.

21871 (OH/RD–89-86-K) **Suitability of inclined plate anchors for guyed transmission towers.** Tsang, R.H.K. (Ontario Hydro, Toronto, ON (Canada)); Radhakrishna, H.S. Ontario Hydro Research Div., Toronto, ON (Canada). 6 Jul 1989. 86p. (MICROLOG–89-06315). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

Tubeco disk anchors with the corrosion protected rod may offer a holding capacity of up to 450 kilonewtons for guyed structures. An assessment of the anchor suitability for Ontario Hydro transmission applications was examined. Four trial installations were performed, followed by full-scale pullout tests, at Essa Transformer Station. Several factors of influence related to the soil strengths and installation parameters were examined. The following installation parameters were investigated to identify their effects on the foundation: excavation procedure, backfilling operation and angle of inclination. It was found that the following factors should be considered in the selection of plate anchors to resist inclined uplift loads: workability and compactability of the native soil to be used as backfill material; dewatering and/or shoring during excavation, if necessary; backfill control to ensure proper compaction, particularly in front of the plate anchor. It was found that the following installation parameters were important: alignment of the plate anchor; proper sealing of the disc washers; installed angle of inclination of the plate anchor; control and inspection, especially if the plate anchor is to be encased in concrete. The method of installation in which the plate anchor is encased in concrete is recommended. 1 ref., 42 figs., 18 tabs.

21872 Vacuum transmission lines for pulse sharpening and diagnostics applications. DiCapua, M.S. (Lawrence Livermore National Lab., CA (USA)); Goerz, D.A.; Freytag, E.K. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract W-7405-ENG-48. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The author discusses their investigation of the propagation of MV electrical pulses along coaxial transmission lines (TL) in vacuum with network simulations and experiments. Their goal was to establish how well a 3 m-long TL would sharpen the output pulse of a relativistic electron beam accelerator. Sharpening occurs as the cathode of the TL emits electrons and the current flow forces the TL into magnetic cut-off. The other goal was to determine how well field emission must be suppressed in a TL to avoid distortion of a propagating pulse. Simulations predict a four-fold risetime improvement (8 ns to 2 ns) through magnetic insulation in a TL with an electrical length (10 ns) comparable to the risetime of the input pulse. In the laboratory they report a five-fold improvement (15 to 3 ns) with a velvet covered 3-m line and a 7.5 fold improvement (2 ns) when a vacuum flashover switch was incorporated between the first third and the last two thirds of the TL. Arguments and TL simulations suggest that even a small fraction (1 or 2%) of Child-Langmuir (CL) space charge limited emission will distort a propagating voltage pulse.

2404 Health and Safety

Refer also to citation(s) 22782

2405 Environmental Aspects

21873 (OH/RD–89-152-K) **Residential magnetic field: Accounting for external sources and residential grounding circuits.** Barrow, D.A. Ontario Hydro Research Div., Toronto, ON (Canada). 14 Jun 1989. 35p. (MICROLOG–90-01175). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A project to characterize the sources of magnetic fields in residential locations was established as part of Ontario Hydro's program to assess the risks, if any, posed by fields due to the electric power system. In this report, a simple model for the strength of the magnetic field at 60 Hz found inside houses is developed to account for the house wiring, and for sources external to the house. In the model the house wiring is reduced to a single circuit carrying the net current on the service drop to the house and the service grounding current. All sources external to the house are combined and represented as a single ambient field assumed to be spatially uniform throughout the volume of the house. This model and a measurmement procedure were tested on 5 houses in locations inside the houses remote from appliances, which were not included in the model. In the main, good agreement was found between actual measured field strengths and those predicted by the model. 4 refs., 10 figs., 6 tabs.

21874 (OH/RD–89-159-k) **A magnetic field probe for use in extremely low frequency (ELF) animal exposure systems.** Scheer, R. Ontario Hydro Research Div., Toronto, ON (Canada). 9 Jun 1989. 6p. (MICROLOG–90-01168). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

As part of a program to measure the effects of extremely low frequency (ELF) fields on animals, a magnetic field probe was developed which could be suspended over a mouse cage to measure localized fields at the bottom of the cage. The device had to be small enough to fit inside a mouse cage, had to reproduce an ELF waveform accurately, its dynamic range should cover fields between 1 μT and 5 μT, there must be a simple relationship between field strength and output signal, and signals outside the range of interest should be filtered out. This paper describes the design and testing of such a device. 7 figs.

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21937

25 ENERGY STORAGE

21875 Energy storage. McLarnon, F.R. (Lawrence Berkeley Lab., CA (USA). Applied Science Div.); Cairns, E.J. *Annual Review of Energy (USA),* 14: 241-272 (1989). DOE Contract AC03-76SF00098.

The authors discuss technologies for storage, conversion, and the use of thermal, mechanical, chemical, electrical, and magnetic energy. They investigate advanced storage technologies which will soon enter the marketplace. They conclude that by the turn of the century advanced systems will permit technologies like electric vehicles and load leveling devices to compete.

2502 Compressed and Liquefied Gas

Refer also to citation(s) 21643

21876 (EPRI-GS–6620-Vol.2) **Compressed-air energy storage using hard-rock geology: Test facility and results: Volume 2, Evaluation of test results: Final report.** Pellin, J. (Societe Electrique de l'Our S.A., Luxembourg (Luxembourg)). Electric Power Research Inst., Palo Alto, CA (USA); Societe Electrique de l'Our S.A., Luxembourg (Luxembourg). c Jan 1990. 733p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents results of the first part of a two-part investigation regarding hard-rock CAES plants. It is a detailed presentation of field data acquired to better understand the "champagne effect" and provide inputs to the second part of the investigation, which conducted model development, calibration, and prediction regarding the "champagne effect." The field data was obtained at SEO's Urschmitt 18-bar test facility, which was suitably modified so that a test program could be developed and carried out over an approximately two-year period. The overall approach proved to be viable, i.e., develop a crude mathematical model of the phenomenon, then formulate a test program based on model calibration needs and hardware capabilities, acquire field data, and iteratively improve the model until it satisfactorily matched experimental observation. In relation to calibration of the computer model, a host of data was obtained for different test configurations, flow rates, and saturation levels. All this data was made available to the model-calibration contractor for evaluation, model calibration, and transient response predictions.

21877 (EPRI-GS–6688) **Compressed-air energy storage: Pittsfield aquifer field test: Test data, Engineering analysis and evaluation: Final report.** Bui, H.V. (ANR Storage Co., Detroit, MI (USA)); Herzog, R.A.; Jacewicz, D.M.; Lange, G.R.; Scarpace, E.R.; Thomas, H.H. Electric Power Research Inst., Palo Alto, CA (USA); ANR Storage Co., Detroit, MI (USA). c Feb 1990. 321p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report documents the results of a comprehensive investigation into the practical feasibility for Compressed Air Energy Storage (CAES) in Porous Media. Natural gas porous media storage technology developed from seventy years of experience by the natural gas storage industry is applied to the investigation of CAES in porous media. A major objective of this investigation is the geologic characterization, deliverability prediction, and operations analysis of the Pittsfield CAES aquifer experiment, conducted in Pike County, Illinois during 1981–85 under EPRI/DOE sponsorship. Emphasis has been placed on applying accepted petroleum engineering concepts to the study of deliverability and on the characterization and quantification of oxygen losses which reportedly occurred at Pittsfield. Other objectives are to apply the natural gas underground storage technology and approach to a general study of CAES feasibility in porous media reservoirs, with emphasis on the practical risks and constraints of air storage in aquifer and depleted natural gas reservoirs, the effects of water on CAES operation, corrosion effects, and a review of air dehydration options.

2504 Capacitor Banks

Refer also to citation(s) 22337

2506 Thermal

Refer also to citation(s) 21937, 21971, 22071

2509 Batteries

Refer also to citation(s) 21885, 21937, 22081

21878 (AD-A–214636/3/XAB) **LiCl-$AlCl_3$-$SOCl_2$ system: Structures, species, and equilibria.** Mosier-Boss, P.A.; Szpak, S.; Smith, J.J.; Nowak, R.J. Naval Ocean Systems Center, San Diego, CA (USA). May 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Electrochemical Society, Vol. 136, No. 5, 1282-1287(May 1989).

One of the major, as yet unresolved, issues in maximizing Li/$SOCl_2$ cell performance is the mechanism of $SOCl_2$ electroreduction. Studies suggest the importance of the composition as well as structural aspect of bulk electrolyte on the kinetics of the charge-transfer process. Madou et al. have provided some evidence for the participation of more than one $SOCl_2$-bearing species. Venkatasetty, in discussing the role of transition metal phthalocyanines in the charge-transfer process, viewed the rate enhancement as due to the formation of thionyl chloride adducts with phthalocyanines.

21879 (EPRI-GS–6718) **Sodium/sulfur battery: Supporting R and D on sulfur-side components: Final report.** McKubre, M.C.H. Electric Power Research Inst., Palo Alto, CA (USA). SRI International, Menlo Park, CA (USA). c Feb 1990. 264p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Sodium/sulfur cell or battery system development is the most intensely pursued new technology that promises cost and performance advantages over commercially available lead-acid batteries. Research studies were performed to develop mechanistic and kinetic understanding of processes that may impair performance or lifetime and to propose remedial actions. In addition to experiments designed to examine kinetic limitations and thermodynamic effects at positive electrodes, the work included studies on the effect of additives on vapor species and corrosion studies on present and alternative structural materials. After developing models based on laboratory work, the results were applied and evaluated using data obtained from cell developers. The work performed provides a firmer basis for fundamental understanding of sodium/sulfur electrochemistry, furnishes an improved basis for interpretation of cell test results, and lays a foundation for means to increase life and performance. 52 refs., 116 figs., 19 tabs.

21880 (LBL–27473) **Enhancement of mass transfer to a rotating cylinder electrode by inert particles suspended in the electrolyte.** Kim, L.H.; Muller, R.H.; Tobias, C.W. Lawrence Berkeley Lab., CA (USA). Jun 1989. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008054. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Mass-transfer rates were investigated to a rotating cylindrical electrode in the presence of suspended particles either more or less dense than the electrolyte. In the case of low-density particles, the limiting-current density for the reduction of ferricyanide increases rapidly with volume fraction of solids up to about 10%, then gradually declines to values near those for the particle-free electrolyte. The transport process is interpreted by a three-zone model in which mass-transfer rate is controlled by different modes of particle behavior in the centrifugal force field. For high-density particles, limiting currents increase monotonically with increasing particle concentration, and the enhancement caused by suspended particles decreases with increasing rotation speed. 28 refs., 10 figs.

21881 (LBL–28164) **Electrocatalysts for oxygen electrodes: Final report.** Yeager, E. (Case Western Reserve Univ., Cleveland, OH (USA)); Gupta, S. Lawrence Berkeley Lab., CA (USA). Oct 1989. 60p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008066. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The overall objective of this research was an in-depth understanding of the factors controlling O_2 reduction and generation on various electrocatalysts and the use of this understanding to identify much higher activity, stable catalysts. 30 refs., 26 figs., 4 tabs.

21882 (PB–90-855750/XAB) **Battery separators. October 1971-October 1989 (Citations from the US Patent data base). Report for October 1971-October 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 77p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855589.

This bibliography contains citations of selected patents concerning compositions and methods of manufacturing battery separators. Microporous membranes, coatings, paper, sheet structures, and non-woven mats are included. A wide variety of battery applications are also discussed. (This updated bibliography contains 192 citations, 22 of which are new entries to the previous edition.)

21883 (PB–90-856568/XAB) **Conductive polymers for batteries. January 1979-December 1989 (Citations from the Rubber and Plastics Research Association data base). Report for January 1979-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 48p. Available from NTISPC N01/MF N01.

Supersedes PB–88-851993.

This bibliography contains citations concerning the development and evaluation of electrically conductive solid-state polymer batteries. Fabrication methods of conductive polymer electrolytes, electrodes, and films are examined. Polyacetylene batteries are emphasized along with various other conductive polymeric materials being tested. (This updated bibliography contains 88 citations, 21 of which are new entries to the previous edition.)

21884 (SAND–89-3039) **Exploratory battery technology development and testing report for 1988.** Magnani, N.J.; Diegle, R.B.; Braithwaite, J.W.; Bush, D.M.; Butler, P.C.; Freese, J.M.; Grothaus, K.R.; Murphy, K.D. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. 92p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90007996. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories, Albuquerque, has been designated as Lead Center for the Exploratory Battery Technology Development and Testing Project, which is sponsored by the US Department of Energy's Office of Energy Storage and Distribution. In this capacity, Sandia is responsible for the engineering development of advanced rechargeable batteries for both mobile and stationary energy storage applications. This report details the technical achievements realized in pursuit of the Lead Center's goals during calendar year 1988.

2510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 21875

21885 (PNL–7203) **Life-cycle cost comparisons of advanced storage batteries and fuel cells for utility, stand-alone, and electric vehicle applications.** Humphreys, K.K.; Brown, D.R. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 422p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90008090. Available from NTIS, PC A18/MF A01 - OSTI; GPO Dep.

This report presents a comparison of battery and fuel cell economics for ten different technologies. To develop an equitable economic comparison, the technologies were evaluated on a life-cycle cost (LCC) basis. The LCC comparison involved normalizing source estimates to a standard set of assumptions and preparing a lifetime cost scenario for each technology, including the initial capital cost, replacement costs, operating and maintenance (O&M) costs, auxiliary energy costs, costs due to system inefficiencies, the cost of energy stored, and salvage costs or credits. By considering all the costs associated with each technology over its respective lifetime, the technology that is most economical to operate over any given period of time can be determined. An analysis of this type indicates whether paying a high initial capital cost for a technology with low O&M costs is more or less economical on a lifetime basis than purchasing a technology with a low initial capital cost and high O&M costs. It is important to realize that while minimizing cost is important, the customer will not always purchase the least expensive technology. The customer may identify benefits associated with a more expensive option that make it the more attractive over all (e.g., reduced construction lead times, modularity, environmental benefits, spinning reserve, etc.). The LCC estimates presented in this report represent three end-use applications: utility load-leveling, stand-alone power systems, and electric vehicles.

29 ENERGY PLANNING AND POLICY

2901 Energy Analysis and Modeling

Refer also to citation(s) 21971, 23248

21886 (DOE/CE–0281) **Federal energy management activities: FEMP update, Autumn 1989.** USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Federal Energy Management Program. Aut 1989. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE90007645. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The FEMP Update, published quarterly by the Federal Energy Management Program (FEMP) provides information that will assist federal managers in their energy management responsibilities. The Update is distributed primarily to federal facility and energy management personnel.

21887 (DOE/EIA–M036(90)) **PC-AEO forecasting model for the Annual Energy Outlook 1990: Model documentation.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. Mar 1990. 371p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90007664. Available from NTIS, PC A16/MF A01 - GPO - OSTI; GPO Dep.

The objective of the PC-AEO modeling system is to make forecasts of national energy trends by fuel and sector for the Annual Energy Outlook published each year by the Energy Information Administration (EIA). The model was built with the aim of representing the most significant national characteristics of US energy markets, within the operating capability of a relatively powerful personal computer. (The model is typically run on a fast "386" type of machine.) A secondary objective was to build the model at the level of detail that could be supported largely by EIA's comprehensive series of annual data publications, typically the Annual Energy Review (AER). The AER summarizes energy supply and demand transactions for the year for particular fuels, including electricity, coal, oil, and natural gas, and presents a national description of the US energy system capability. The extent that the model goes beyond the national data published by EIA reflects the extend that EIA analysts consider that regional trends dominate the national aggregate statistics. Fuel switching and natural gas pricing are cases in point. The integrated PC-AEO model consists of a series of linked spreadsheets, most of which are specific to a fuel supply or end-use sector of consumption. Many are written to characterize the data at the four Census region levels for the United States (see Figure 1). The individual spreadsheet models were designed so that each could be run on a conventional but highly capable IBM-compatible personal computer using Lotus 1-2-3 as the host language.

2902 Economics and Sociology

Refer also to citation(s) 21178, 21313, 21636, 21886, 21911, 21918, 21919, 21920, 21922, 21933, 21938, 23248

21888 (EMR/EMAS–90-00944) **Long-term energy outlook, 1987-2005: Working paper.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Div. of Energy Market Analysis and Statistics. Jun 1988. 80p. (MICROLOG–90-00944). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is a compendium of work prepared over 6 months to April 1988 on Canada's long-term energy outlook. The individual

components contain analysis of long-term trends in the world oil market, associated implications for domestic energy prices, macroeconomic assumptions and demand for major types of energy by sector and region within Canada to 2005, and supply and net trade projections for each of the major fuels. Two sets of summary tables are provided in an appendix. The results are based on the use of the Inter-Fuel Substitution Demand (IFSD) modelling system. In the world oil market, 2 base-case price scenarios were developed consistent with a low but rising price pattern ($15-$24, $18-$32). Domestic fuel prices are tied directly to international prices, with electricity prices rising at just under the rate of inflation and coal prices remaining flat. Domestic energy demand will decline slightly and some substitution from oil continues. Electricity's share rises by the largest amount. Oil supply will decline until the mid-1990s, then rebound, with Canada a growing net importer of light oil. Natural gas demand will rise, with supply just covering total demand in the low price case and substantial surpluses remaining in the high price case. Electricity generation will increase at about 2.6% per annum. Significant gains in production, up to 3.5% per annum, could be realized for coal. 15 figs., 33 tabs.

21889 (IEA-HPC-WR–2, pp. 21-25) **The North American market.** Bose, J.E. (Oklahoma State Univ., Stillwater (USA)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

A review of the present inventory of residential and light-commercial buildings in the US is presented and used to estimate the market potential of ground-source heat pumps. Estimates of the number of units installed in 1985/86 range from 1500 to 15000 and system costs range from 4500 to 10000 US Dollars for a 11 KW (3 ton) cooling range capacity system. Utility programs which encourage the use of these systems are considered important. These programs could help in reducing installation costs. Experience at Oklahoma State University in operating training programs or ground source heat pumps is also presented. (UA).

21890 (OH/RD–706.01(#245)) **Short-term economic outlook: Annual review.** Ontario Hydro Research Div., Toronto, ON (Canada). Sep 1989. 27p. (MICROLOG–89-06380). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This update on the short-term economic outlook from the perspective of Ontario Hydro replaces a similar review issued in May 1989. The main difference from the previous review is the incorporation of the Federal Goods and Services Tax, scheduled to be introduced on January 1, 1991. The document details changes since the May 1989 review in economic growth, unemployment, inflation, financial markets, energy prices, and important risks. Forecast tables are given for energy consumption in Ontario, Canada, the United States. Supporting data includes historical and forecast data yearly from 1964-1993 and by 5-year periods from 1991-2025. Forecast comparisons are given for Canadian and Ontario economic indicators. 23 tabs.

21891 (OH/RD–706.01(#281)) **Long-term economic outlook: Annual review.** Ontario Hydro Research Div., Toronto, ON (Canada). Sep 1989. 12p. (MICROLOG–89-06380). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This update on the long-term economic outlook from the perspective of Ontario Hydro replaces a similar review issued in May 1989, with the main difference from the previous review being an increase in the inflation rate due to the introduction of the federal Goods and Services Tax, scheduled to be introduced on January 1, 1991. The document details changes since the May 1989 review in Ontario economic growth, sectoral distribution of output, inflation and the consumer price index, interest rates, the Canadian dollar exchange rate, and energy prices. Forecast tables are given for energy consumption in Ontario, Canada, the United States, and the Ontario industrial structure. 12 tabs

21892 **Linking life-styles and energy use: A matter of time.** Schipper, L. (Lawrence Berkeley Lab., CA (USA). Applied Science Div.); Bartlett, S.; Hawk, D.; Vine, E. *Annual Review of Energy (USA)*, 14: 273-320 (1989).

In this paper, the authors explore the links between life-styles and energy use. While they focus on the United States, they illustrate some points using examples from other countries, particularly where these countries differ significantly from the United States. They focus on changes in an individual's or household's activities that are not motivated per se by a desire to save energy. They study observed behavior. To understand the relationship between life-styles and energy use, they review the structure of energy use by end-use sector. They propose a scheme for measuring consumer activities, which leads to a new description of consumers' energy use. The authors review demographic and social factors that may constrain activity choices, then return to the activity-based description of energy use to speculate on how changes in consumer activities could cause important changes in sectoral demand in the future.

2903 Environment, Health, and Safety

Refer also to citation(s) 21138, 21480, 21519, 21597, 21907, 21917, 22031, 22060, 22061, 22507, 22512, 22513, 22529, 22550, 22551, 22554, 22555, 22556, 22557, 22558, 22559, 22560, 22561, 22562, 22563, 22564, 22565, 22566, 22567, 22568, 22569, 22570, 22571, 22572, 22573, 22574, 22575, 22614, 22617, 22618, 22619, 22620, 22621, 22622, 22623, 22624, 22625, 22626, 22627, 22628, 22629, 22630, 22631, 22632, 22633, 22634, 22635, 22636, 22637, 22638, 22639, 22640, 22641, 22642, 22643, 22644, 22645, 22646, 22647, 22648, 22649, 22650, 22651, 22652, 22653, 22654, 22655, 22656, 22657, 22658, 22659, 22660, 22661, 22662, 22663, 22664, 22665, 22666, 22667, 22668, 22669, 22670, 22671, 22672, 22673, 22674, 22675, 22676, 22677, 22678, 22679, 22680, 22681, 22682, 22683, 22684, 22685, 22686, 22687, 22688, 22689, 22690, 22691, 22692, 22693, 22694, 22695, 22696, 22697, 22698, 22699, 22700, 22701, 22702, 22703, 22772, 22773, 22779

21893 (OI–CE02872, pp. 316-349) **Alternative fuels to address California air quality issues: Current perspectives.** Lloyd, A.C.; Wuebben, P.; Leonard, J.H. Ortech International, Mississauga, ON (Canada). Oct 1989. (CONF-890682–: 5. Windsor workshop on alternative fuels, Windsor (Canada), 12-15 Jun 1989; CE–02872). In *Proceedings of the fifth Windsor workshop alternative fuels.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The South Coast Air Quality Management District is responsible for air quality in the four counties of Los Angeles, Orange, Riverside and San Bernardino. The District complies with the federal standards for SO_2 and Pb, but the maximum O_3 concentrations reach about 3 times the federal health standard, CO and fine (less than 10 μm) particulate matter reach maximum levels of twice the federal standard, and the District is the only area in the USA that still fails to meet the NO_2 standard. The goals of the District's clean fuel program are the following: to attain the penetration objectives identified in the Air Quality Management Plan (AQMP); to promote the development and commercialization of clean fuels vehicle technology; to sponsor demonstrations of commercially viable technologies; and to develop fleet acquisition rules consistent with the availability of technology. This paper focuses on the anticipated role of cleaner-burning alternative fuels to meet the transportation sector goals of the revised AQMP. The current perspectives of methanol, electricity, gaseous fuels (compressed natural gas and liquefied petroleum gases), ethanol and hydrogen as automotive fuels are discussed. Efforts are underway to set up an emissions data base. The contributions of different automotive fuels to the earth's global warming and to ozone formation at ground level are compared. 14 refs., 3 tabs.

21894 (PB–90-130444/XAB) **Guideline series: Guidance document for residential wood-combustion emission-control**

measures. Davis, B.; Read, B. Radian Corp., Austin, TX (USA). Sep 1989. 236p. Available from NTIS, PC A11/MF A02.

The publication was prepared to provide guidance to State and local air pollution control agencies with regard to emission-control measures for residential wood combustion (RWC). The guidance is specifically directed to agencies that are required by the U.S. EPA to demonstrate through the State implementation planning process that the national ambient air quality standard for PM-10 will be attained. There are four categories of RWC emission control measures: public awareness, combustion efficiency, restriction or reduction in the number of RWC devices, episodic curtailment. A hierarchy of effectiveness and reliability of emission-control measures is presented. Methods for developing estimates of RWC emissions are presented in order to apply a quantitative estimate of effectiveness of control measures.

21895 (PB–90-131046/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on mine health research before the Subcommittee on Compensation, Health and Safety; House Committee on Education and Labor, by Edward J. Baier, April 4, 1977.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 4 Apr 1977. 12p. Available from NTIS, PC A03/MF A01.

The statement concerned mine health research and technical assistance programs sponsored by the National Institute for Occupational Safety and Health (NIOSH). NIOSH conducted research directed toward protection of life and health, detection of respiratory impairment, and prevention of occupational diseases of coal miners. NIOSH also established coal-mine health standards and assures the availability of medical examinations for underground coal miners. NIOSH cooperated in a joint program to test and certify respirators and coal-mine-dust personal samplers. Miners suffer from various work hazards including exposure to coal dust, radiation and excessive noise levels. There was also evidence of increased mortality due to lung cancer and stomach cancer. There was inadequate data on the degree of exposure to many of the hazards present in the mines. Workers in nonmetal mines and mills were exposed to an even wider range of pneumoconiosis producing dusts than were coal miners. Health standards have been promulgated by the Department of the Interior for metal and nonmetal mining operations. NIOSH was engaged in cooperative research with other agencies to help ensure the future safety of miners.

21896 (PB–90-131053/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on mine health research before the Subcommittee on Labor, Senate Committee on Human Resources, by Edward J. Baier, March 31, 1977.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 31 Mar 1977. 11p. Available from NTIS, PC A03/MF A01.

The statement concerned the research and technical assistance programs offered by the National Institute for Occupational Safety and Health (NIOSH) in the area of miner health and safety. While under the Federal Metal and Nonmetallic Mine Safety Act NIOSH has no legislated responsibility, this and the earlier similar organizations have conducted considerable research in this field under the Public Health Services Act. Under the Occupational Safety and Health Act of 1970, NIOSH has developed recommended standards for health hazards facing workers in metal mines. About 2.1 million of the 48.8 million dollar 1977 budget for NIOSH was allocated to coal-mine health research and another 2.1 million for related services to coal miners and mine operators. Recognized health hazards of mining include coal workers' pneumoconiosis, silicosis, other forms of respiratory impairment, hearing loss due to excessive noise exposure, lung cancer, and accidents. Technical assistance offered by NIOSH included investigation of problems resulting from exposure to heat stress, creosote, asbestos, and resins used in roofbolting. Health research also considered respirable dust-suppression techniques, radiation exposures, and the presence of noxious gases from mining equipment.

21897 (PB–90-132192/XAB) **Information Resources Directory (IRD), Fall 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Information Resources Management. 1989. 634p. (OCPA–19M-4001). Available from NTIS, PC EE09/MF A04.

This Directory is a comprehensive guide to valuable Environmental Protection Agency (EPA) information resources. It includes the following sections: List of major EPA documents, organizational charts, map of EPA regional offices with addresses and headquarters mail codes; synopsis of EPA information systems, data bases, and models listed by responsible EPA program or regional office; listing of EPA dockets, hotlines, bulletin boards, and clearinghouses; EPA libraries; environmental contacts at other Federal agencies; environmental organizations, advocacy groups, and trade associations; explanation of EPA acronyms and abbreviations; and glossary of environmental terms in non-technical language.

21898 (PB–90-133372/XAB) **Toxic Substances Control Act (TSCA): Report to Congress for fiscal years 1987 and 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Pesticides and Toxic Substances. Oct 1989. 91p. (EPA–560/1-89/001). Available from NTIS, PC A05/MF A01.

See also PB–83-262626.

When Congress enacted the Toxic Substances Control Act (TSCA) in 1976, it gave the Environmental Protection Agency (EPA) the authority to identify and control chemical hazards to human health and the environment. This tenth report to Congress fulfills the reporting requirements for information about the administration of the Act found in TSCA sections 30, 9(d) and 28(c) for Fiscal Years 1987 and 1988. An overview of other major actions under TSCA is found in Appendices A and B of the report. TSCA Title I gives EPA the authority to gather certain basic information on chemical risks from chemical manufacturers and processors, and to require companies to test selected existing chemical substances and mixtures (chemicals) for toxic effects.

21899 (PB–90-134529/XAB) **Striking a balance: The environmental challenge of development.** International Bank for Reconstruction and Development, Washington, DC (USA). c 1989. 57p. Available from NTISMF A01.

Color illustrations reproduced in black and white; Microfiche copies only. Paper copy available from World Bank, 1818 H St., NW, Washington, DC 20433.

Contents include: a new era of environmental understanding; making the environment a bank commitment; learning and adapting; making choices; (agriculture, deserts and arid lands, forests, biological diversity, energy, pollution, health, population, cultural property); the lasting legacy; the challenge ahead.

21900 (PB–90-137365/XAB) **Health assessment for GEMS Landfill National Priorities List (NPL) site, Gloucester Township, Camden County, New Jersey, Region 2. CERCLIS No. NJD980529192. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Jun 1989. 24p. Available from NTIS, PC A03/MF A01.

The GEMS Landfill is on the National Priorities List. The site covers approximately 60 acres. Contaminants at the GEMS Landfill site include volatile organic compounds, polynuclear aromatic hydrocarbons, and inorganic compounds. A monitoring program will be implemented to assess the effectiveness and reliability of remedial action. Human exposure to cadmium, lead, methylene chloride, benzene, and carcinogenic polyaromatic hydrocarbons may occur, be occurring and have occurred in the past via ingestion, inhalation, and dermal contact.

21901 (VR–89-05, pp. 328-332) **The Dutch coordination commission for measurement of radioactivity and xenobiotic materials.** Went, G.F. van (Coordinatie-Commissie voor de Metingen van Radioactiviteit en Xenobiotische Stoffen (CCRX), Rijswijk (Netherlands)); Buurma, IJ. Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. (In Dutch). In *Reports from the RIVM 1988*. Order Number DE90619461. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The Dutch Coordination-Committee for Measurements of Radioactivity and Xenobiotic materials (CCRX) coordinates systematic measuring programmes of the government departments and institutes which are, dependent of the responsibilities of the departments under which they report, directed upon various compartments of the environment: air, surface waters, soil, vegetable and animal food, and in some cases man, in order to achieve an

appropriate monitoring of artificial radioactivity and the presence of xenobiotic materials in the (Dutch) biologic environment. In this report the National Measuring Programmes (NMP) radioactivity and Xenobiotic materials of the CCRX are outlined and the most important conclusions with regard to the situation of the environment, drawn from the measurements performed in the framework of the NMP, are summarized. (H.W.).

2904 Energy Resources

Refer also to citation(s) 21591, 21875, 21892, 21899

21902 (EMR–M1-5/1987) **EMR [Energy, Mines and Resources Canada] annual report 1986/1987.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). 1988. 99p. (MICROLOG–90-00883). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report presents information on the department, highlights of the year's activities, and more detailed information on programs in energy, and minerals and earth sciences. A list of Crown corporations responsible to the Department, as well as the regional offices are given. A financial summary is included. Highlights of the year in energy policy included the removal of the Petroleum and Gas Revenue Tax, the reaching of agreement between Saskatchewan and the federal government on terms for the NewGrade heavy oil upgrader and the Husky Oil upgrader, and the initiation of the Canadian Exploration and Development Incentive Program which will provide direct cash assistance to the oil and gas industry. In the energy commodities sector, natural gas prices were deregulated, and the National Energy Board completed an inquiry into the regulation of electricity exports. The Canada Oil and Gas Lands Administration gave conditional approval to the development plan and the benefits plan for the Hibernia development project, the first shipment of Beaufort Sea oil took place, the private sector task force on safety in oil and gas operations on frontier lands submitted its report, and the Arctic escape system, a prototype amphibious vehicle, was successfully tested in the North.

21903 (ERCB–89-40) **Energy Alberta 1988.** Energy Resources Conservation Board, Calgary, AB (Canada). 1989. 51p. (MICROLOG–90-00664). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report of the Board, an independent body which ensures the orderly, efficient, economic, safe and environmentally sound development of the energy resources of Alberta, reviews energy development for the year within the province. The report covers the establishment of the Board and its place in dealing with the energy industry, as well as its operations and activities in defence of the environment. A summary of the province's energy resources, sales and distribution, revenues, investment, and employment is given. Highlights of the year include establishment of a new ethane policy; completion of a 2-year air quality study as part of the Acid Deposition Research Program; new sulfur recovery guidelines for pollution control; and a substantial increase in raw coal production and marketable coal deliveries. 40 figs., 4 tabs.

21904 (NBNRE/FM–89-06258) **[New Brunswick] Natural Resources and Energy, annual report, 1987-88.** New Brunswick Dept. of Natural Resources and Energy, Fredericton, NB (Canada). Minerals and Energy Div. 1988. 115p. (MICROLOG–89-06258). Available from PC New Brunswick Dept. of Forest, Mines and Energy, Centennial Bldg., PO Box 6000, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This annual report presents information on the activities and achievements of the Department in the management of timber, fish and wildlife, minerals and energy, and land. Projects in each of the areas are summarized and include programs, functions, and expenditures of both operating and capital funds as well as the cost of activities funded under two federal -provincial development agreements. Total expenditures of the Department are given also. Data are included for the past 5 years on private and Crown land development, forestry and silviculture, wildfire, and fuelwood program, recreational fishing and hunting, trapping, mineral production and value, energy consumption and home energy conservation loans, and leases of Crown lands. 3 figs., 46 tabs.

21905 (NS/EM–88-3) **Mines and Minerals Branch report of activities 1988, part A.** MacDonald, D.R.; Brown, Y. (eds.). Nova Scotia Dept. of Mines and Energy, Halifax, NS (Canada). 1988. 206p. (MICROLOG–90-00882). Available from PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This publication provides brief summaries of all major programs and presents preliminary results where possible. Reports are grouped by sponsoring division or agency and include the Divisions of Energy Resources, Mineral Development, and Mineral Resources; universities and colleges; and the Canada-Nova Scotia Mineral Development Agreement. Coverage includes an update of onshore petroleum activity, as well as specific locations; general reports on mineral exploration monitoring, core library activities, the Land Use Policy Development Project, automation in the Division, and specific minerals projects; research projects at Acadian University, St. Francis Xavier University and the University College of Cape Breton; and geological analysis of various sites in the province. 73 figs., 12 tabs.

21906 (PB–90-129669/XAB) **Mineral resources of the Ragged Top Wilderness Study Area, Pima County, Arizona.** Nowlan, G.A.; Peterson, J.A.; Pitkin, J.A.; Hanna, W.F.; Kreidler, T.J. Geological Survey, Alexandria, VA (USA). 1989. 28p. (USGS-BULL–1702-H). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600134.

The Ragged Top Wilderness Study Area (AZ-020-197), for which mineral surveys were requested by the U.S. Bureau of Land Management, encompasses 4,460 acres in southcentral Arizona. Field work was carried out in 1987 by the U.S. Bureau of Mines and the U.S. Geological Survey to appraise the identified (known) resources and assess the mineral resource potential (undiscovered) of the wilderness study area. The study area includes the northern part of a mineralized area that includes the Silver Bell porphyry copper deposits. Despite this proximity to a major mine and the presence of several mines and prospects within and near the study area, no metallic resources were identified. Part of the southwest corner of the study area has high resource potential for gold, silver, lead, vanadium, barite, molybdenum, copper, and zinc in vein deposits. Adjacent parts of the study area to the north, west, and south have moderate resource potential for zinc, lead, barite, molybdenum, gold, silver, and copper in similar veins.

21907 (PB–90-134537/XAB) **Philippines: Environment and natural resource management study. World Bank country study.** International Bank for Reconstruction and Development, Washington, DC (USA). c 1989. 202p. Available from NTISMF A02.

Library of Congress catalog card no. 89-16502. Microfiche copies only. Paper copy available from World Bank, 1818 H St., NW, Washington, DC 20433.

This study addresses the most significant issues of natural-resource management in the Philippines. These include the disappearence or degradation of forests; erosion and changes in hydrological regimes; the conversion of mangrove swamps to fishponds; degradation of coral reefs; and depletion of nearshore fisheries through overfishing and destructive techniques. The issues addressed concern the extent and rate of degradation of these resource stocks, the impact thereof on the national economy, and the scope for ameliorative measures through policy responses, management changes, and investments. The Government is responsible for management of public resources, which include over half of the land area of the Philippines as well as the coastal waters. Historically, public management has been less than optimal,

as evidenced by an unsustainable rate of deforestation and the recent stagnation or decline in extractive fisheries.

21908 (PRM–CE02870, pp. 18) **Antarica: An overview.** Thomas, R.B. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The polar regions fo our globe are generally regarded as being similar: cold, white and hostile, but from the early days of exploration those who experienced both Arctic and Antarctic conditions soon found them very different. Since the turn of this century explorers, scientists and administrators from a few nations have been expanding our knowledge and understanding of the Antarctic, preserving it from international rivalry and conflict, protecting its unique environment and promoting its freedom for scientific research. The past decade has seen a shift in this attention, with the recognition that Antarctica may possess vast resources to provide for an energy and food hungry world, but the feasibility of operating safely and efficiently has yet to be fully addressed. Despite the differences in geography, politics, human habitation and activities and indeed in climate, the Arctic and Antarctic do share many common problems in the logistical support required of all human activities and as new developments take place the experience in one hemisphere can be of considerable value to the other. This overview of the Antarctic touches on all these questions, and considers exploration and scientific activities, the Antarctic Treaty, energy-related discoveries, operations in the hostile Antarctic environment, and future possibilities. 10 figs.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 21636, 21728, 21875, 21964, 21975, 21976, 21981, 21993, 22047, 22085, 22212, 22293, 23222

21909 (AIST–8901-1) **Japan's Sunshine Project. 1988 Annual summary of comprehensive research.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 155p. (In Japanese). Order Number DE90753035. Available from NTIS (US Sales Only), PC A08/MF A01.

An outline of 1988 annual summary of Sunshine Project was described. On ocean thermal energy conversion system; non-azeotropic mixture working fluid cycle and measures for dissolved gases in open cycle in which seawater was used as a working fluid, were investigated. Furthermore, effectiveness of deep sea mooring system and planning of total system, were studied. On wind energy conversion system; wind-mill blades, optimum control system and transmission system were researched, and elemental technology development on MW-class system and its evaluation were performed. Wind observations were also carried out at Cape Murotomisaki and Bohnotsu-cho. On the biomimetic conversion of solar energy; developments of photoelectric conversion system by thin films of natural or synthetic dyes and of construction method of thin film electrodes, were carried out. On the production of liquid fuel from woody biomass, the effect of addition of organic solvent and rapid heating decomposition process, were studied. Clarification of hydrogen production mechanism of photosynthetic microorganisms and electron-transporting system on the hydrogen evolving, was performed. The production of new fuel oil from biomass by microbial cultivation and thermoelectric elements were also researched. Other supporting researchs and international cooperative works were also described. 62 figs., 14 tabs.

21910 (AIST–8901-2) **Japan's Sunshine Project. 1988 Annual summary of comprehensive research.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 147p. Order Number DE90753036. Available from NTIS (US Sales Only), PC A07/MF A01.

An outline of 1988 annual summary of Sunshine Project was described. On ocean thermal energy conversion system; non-azeotropic mixture working fluid cycle and measures for dissolved gases in open cycle in which seawater was used as a working fluid, were investigated. Furthermore, effectiveness of deep sea mooring system and planning of total system, were studied. On wind energy conversion system; wind-mill blades, optimum control system and transmission system were researched, and elemental technology development on MW-class system and its evaluation were performed. Wind observations were also carried out at Cape Murotomisaki and Bohnotsu-cho. On the biomimetic conversion of solar energy; developments of photoelectric conversion system by thin films of natural or synthetic dyes and of construction method of thin film electrodes, were carried out. On the production of liquid fuel from woody biomass, the effect of addition of organic solvent and rapid heating decomposition process, were studied. Clarification of hydrogen production mechanism of photosynthetic microorganisms and electron-transporting system on the hydrogen evolving, was performed. The production of new fuel oil from biomass by microbial cultivation and thermoelectric elements were also researched. Other supporting researchs and international cooperative works were also described. 53 figs., 17 tabs.

21911 (LBL–28407) **Energy technology for developing countries: Issues for the US National Energy Strategy.** Lawrence Berkeley Lab., CA (USA). Dec 1989. 47p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008056. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This study explores the role of energy among developing countries to better understand how these energy issues impact the United States. We conclude that the energy choices made by developing countries already have major impacts on the United States. These impacts will grow in the coming decades. We also note that present efforts to provide energy assistance to developing countries are very limited, compared with the magnitude of the problems being faced. We are convinced that improved energy technologies, as well as training in their use, and effective mechanisms of technology transfer, are an important ingredient in solving the problems.

21912 (NBNRE/FM–90-00677) **New Brunswick Natural Resources and Energy annual report 1988-1989.** New Brunswick Dept. of Natural Resources and Energy, Fredericton, NB (Canada). [1989]. 110p. (MICROLOG–90-00677). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report focuses on the achievements of departmental programs in timber, fish, wildlife, minerals, energy, and Crown land resources. The report provides a summary of activities and accomplishments during the past year for each project in each program, including expenditures. These expenditures include both operating and capital funds, as well as the total cost of activities funded under federal/provincial development agreements and other sources as indicated. The energy management program is divided into non-renewable and renewable resources, conservation, and program support. Activities in the non-renewable field included demonstration retorting of oil shale, the completion of a study to determine the feasibility of using shale oil asphalt as an additive to upgrade or to completely substitute for conventional asphalt and the initiation of a project to investigate potentially recoverable by-products and/or methods to utilize coal/oil shale ash. In the renewable energy field, a study of the socio-economic impact of wood energy from 1988-2008 was carried out and 5 companies were selected to submit proposals for the construction of a 25 MW wood residue-fueled electric generating plant. In the conservation area, development of a provincial energy management program was initiated, with phase I involving an energy consumption profile for all provincially-owned facilities. A performance monitoring project was initiated on a heat pump system which recovers waste heat from the kitchen and laundry of the Spencer Nursing Home near Moncton. 45 tabs.

21913 (OH/RD–89-89-K) **[Ontario Hydro Research Division] Some notable accomplishments, 1984-88.** Hanson, W.G.; Jeppesen, B.C. Ontario Hydro Research Div., Toronto, ON (Canada). 19 May 1989. 39p. (MICROLOG–90-00404). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This paper contains a compilation of high-benefit research projects which reached technical completion in the years 1984 to 1988 has been compiled. For purposes of discussion benefits have been catagorized into the three categories, realized benefits, expected benefits and benefits difficult to quantify. Some of these projects include: Probabilistic Uprating of Middleport Transformer Station, Residential Hot Water Use Patterns, Lighting Location Network, Innovative Heat-Pump Technology, Porcelain Insulator Failure Mechanism, Burner Assisted Heat Pump, and Separable Insulated Connector Tool. Realization of the benefits from the first two categories is virtually certain. Calculated net benefits, based on only a few easy-to-quantify projects, total $650M. This figure represents only a small fraction of the total benefits generated by the Research Division in this period. The gross cost of operating the Division over the same time period was about 305 M$ 3 tabs.

21914 (PCCIM–CE02873, pp. 43.1-43.7, Paper 43) **Alberta's Reclamation Research Program.** Powter, C.B. (Alberta Environment, AB (Canada)). Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges*. Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Substainable economic development ensures that the utilization of resources and the environment today does not damage the prospects for their use by future generations. One mechanism for achieving sustainable development in the non-renewable resource sector is reclamation. Alberta was the first province to develop regulations that ensure that the disturbed lands be returned to productive use. The provincial government established a reclamation research program in 1978, which identifies the most efficient methods for achieving acceptable reclamation in Alaberta. The Funding for the program is provided by Aberta's Heritage Savings Trust Fund, Land Reclamation Program. An interdepartmental Reclamation Research Technical Advisory Committee (RRTAC), consisting of members representing the Alberta Government Department of Agriculture, Energy, Forestry, Lands and Wildlife, and Environment, as well as the Alberta Research Concil, coordinates and fosters reclamation research in four major program areas, which correspond to Alberta's major industrial activities and biophysical regions: plains voal, where agricultural concerns are dominant; mountains and foothills coal, where recreation, forestry, whidlife and watershed concerns are dominant; oil sands, where wildlife and forestry concerns exits; and oil and gas, where agricultural and forestry concerns exist. The RRTAC has proven to be very successful in providing information of use to both the government regulatory authorities and to industry. One of the reasons for this success has been the cooperation between government and industry in developing research goals and objectives, and in jointly managing the projects. Funding from industry, either directly in terms of contract dollars or in terms of site construction costs, has greatly increased the scope and quality of the research undertaken.

21915 (SAND–89-2654) **Sandia Technology: Volume 14, No. 1.** Maydew, R.C.; Leonard, J.A.; Calek, J.F.; Dale, B.C.; Floyd, H.L.; Pruett, H.; Parrott, L. (eds.). Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 52p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008027. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report contains information on the following topics: (1) SEMATECH and Sandia announced, at a press conference in August, the formation of a Semiconductor Equipment Technology Center (SETEC); (2) attitude control for rocket payloads; (3) the Sandia lightning simulator; (4) advanced limiter Test-1, pointing the way to improved performance in magnetic confinement fusion research; (5) strained metal overlayers; and (6) radiation hardened microprocessor development.

21916 **Laser applications.** Edelson, M.C. (Ames Lab., IA (USA)). *JNMM (Journal of Nuclear Materials Management) (USA)*, 18(1): 95-98 (Nov 1989).

The breadth of current applications of laser technology is described. It is used as the basis for extrapolating to future application in such activities as AVLIS, SIS, ICP-MS, and RIMs.

2906 Nuclear Energy

Refer also to citation(s) 21490, 21713, 21923, 21925, 21926

21917 (GAO/NSLAD–89-35) **Hazardous waste: DOD efforts to reduce waste.** General Accounting Office, Washington, DC (USA). National Security and International Affairs Div. 1989. 41p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

The Department of Defense is a major generator of hazardous waste, which includes contaminated sludge, solvents, acids, and heavy metals that are dangerous to humans and the environment if disposed of improperly. DOD generates over 400,000 tons each year from industrial processes primarily used to repair and maintain weapon systems. The 1984 Hazardous and Solid Waste Amendments require that all hazardous waste generators have minimization programs. In response, DOD delegated responsibility for developing and implementing such programs to the Air Force, Army and Navy. The services are identifying methods for reducing the quantity of waste generated, such as process changes and material substitutions. The services began to implement minimization programs in the mid-1980s and are attempting to reduce hazardous waste generation levels by 50 percent by 1992. This report discusses how they will have difficulty monitoring their progress because generation data are unreliable.

21918 (GAO/RCED–89-2) **Nuclear waste: DOE's method for assigning defense waste disposal costs complies with NWPA.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. 1989. 30p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

The Nuclear Waste Policy Act established a program within the Department of Energy for disposing of commercial nuclear waste in one or more deep underground repositories. The act requires DOE to allocate the costs of developing, constructing, and operating the repository or repositories between the generators of commercial and defense waste. Further, the act requires that when federally owned or generated defense waste is placed in a repository, the federal government's share of the costs must be equivalent to the fees paid by commercial utilities. In this report, the DOE's cost allocation method is found to comply with the act's requirements for full cost recovery and equivalency.

21919 (GAO/RCED–89-21) **Energy management: DOE should improve its control over work for other federal agencies.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. 1989. 44p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

The products and services that the Department of Energy provides to non-DOE entities, primarily other federal agencies, are reported. They have increased significantly since 1980. Most non-DOE work is authorized under the Economy Act of 1932, which allows federal agencies to obtain goods and services from other federal agencies as long as the work cannot be provided as conveniently or cheaply by the private sector. The act also requires performing agencies to recover actual costs from the sponsoring agencies. Other legislation allows the department to perform work for non-DOE existing sponsors on either a reimbursement or cash advance basis. While DOE's existing policies concerning non-DOE work generally conform to the pertinent legislation, effective control may not be assured because of inconsistent implementation at the

field office level. Implementation varies because there are no established standards for overseeing non-DOE work. According to this analysis, although DOE has recently taken action to eliminate certain financial weaknesses associated with non-DOE work, a number of other controls could be strengthened.

21920 (GAO/RCED–89-41) **Nuclear regulation: NRC's security clearance program can be strengthened.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. 1989. 28p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

The Nuclear Regulatory Commission routinely waives its background investigation requirements for new hires. NRC security staff estimate that 99 percent of new employees are hired before they receive a security clearance. They say waivers are used because the Office of Personnel and Management takes too long to conduct the required background investigations. NRC policies do not require reinvestigation of the background of nearly 50 percent of its clearance holders. Therefore, NRC does not know whether circumstances in some employees' lifestyle have changed, making them security risks. Also, NRC does not have accurate clearance information to effectively manage its program. For example, its computerized system does not have all the data needed to determine when reinvestigations should be requested. This report proposes that, to enhance security and improve the effectiveness of its clearance program NRC should require periodic reinvestigations for all employees, validate and update the security clearance database, and expedite a decision to issue either a policy statement or a regulation regarding access to commercial nuclear power plants.

21921 **Life begins at 40.** McDowell, S.C.T. (Lamb Associates, Germantown, MD (US)). *JNMM (Journal of Nuclear Materials Management) (USA)*, 18(1): 71-72 (Nov 1989).

The role of the New Brunswick laboratory and its contributions to the U.S. Government over its 40 years of operation are discussed. They are traced from the perspective of the U.S. Department of Energy (DOE).

2908 Heat Utilization

Refer also to citation(s) 22055, 22056, 22058, 22059, 22074, 22075

2910 Conservation

Refer also to citation(s) 21886, 21926, 21949, 21998, 22016, 22029, 22031

21922 (EMR/CANMET–81-25(TR), pp. 33-45) **The energy situation.** Hislop, R. (Consumer's Gas, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

This paper provides a broad discussion on energy supply and pricing in the near future with special reference to Canada. Both domestic and international oil supply are likely to remain tight bringing about an increase in the international price for oil. Canadian oil pricing policies will mean a continued support for oil prices but with a slow rise toward international prices. Natural gas will remain in plentiful supply and the disparity between oil and gas prices will widen. It seems likely that Canada will be able to continue to export natural gas. Low Canadian prices for oil will impede development of Alberta oil sands. Frontier oil will be difficult to develop economically. The current and future supplies of electricity are good and it is likely that Canada will continue to export electricity. It is recommended that Canada encourage consumers to switch to natural gas, that the natural gas delivery infrastructure be expanded, and that energy conservation be vigorously pursued.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 21888, 21890, 21891, 21892

21923 (DOE/EIA–0173(89)) **Energy Information Administration annual report to Congress, 1989.** USDOE Energy Information Administration, Washington, DC (USA). 13 Feb 1990. 72p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90007494. Available from NTIS, PC A04/MF A01 - GPO - OSTI; GPO Dep.

This annual report to congress includes accomplishments and points of interest of the EIA. (JEF)

21924 (EMR/EMAS–90-01054) **1988 Canadian energy statistics review.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Div. of Energy Market Analysis and Statistics. 1988. 43p. (MICROLOG–90-01054). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This annual review of Canadian energy production and domestic demand, energy supply and demand by commodity (petroleum, natural gas, electricity, coal), energy use in the economy, and energy prices is presented mainly through tables and graphs. An overview of the conditions during the year is also given. During 1988. energy production and demand reached record levels, influenced by the weather, lower oil and gas prices, the buoyant economy, reduced conservation efforts and higher export demand. Electricity exports were reduced, especially by Quebec and western Canada, with Manitoba becoming a net importer for the first time since 1978. The inceases in petroleum import and refined product output and export were also strongly influenced by the return to operation of the export-oriented refinery at Come-by-Chance in Newfoundland. 16 figs. 22 tabs.

21925 (GRI–90008274) **1989 GRI baseline projection of US energy supply and demand to 2010: Gas Research Insights.** Holtberg, P.D.; Woods, T.J.; Lihn, M.L.; McCabe, N.C. Gas Research Inst., Chicago, IL (USA). Dec 1989. 115p. Available from OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631.

This report summarizes the 1989 GRI Baseline Projection of US Energy Supply and Demand, which has been adopted as a major input to the planning cycle leading to the development of Gas Research Institute's (GRI) 1991 research and development program. The baseline projection represents the GRI planning outlook for the economic and energy supply and demand situation to the year 2010. The 1989 projection was prepared independently by GRI using publicly available data and a framework of commercially available models that GRI has developed over several years. A series of summary tables, sectoral breakdowns of energy demand, and the natural gas supply and price trends are presented. The appendices include a discussion of the methodology and assumptions used to prepare the 1989 projection, an analysis of the potential for higher levels of gas demand, a description of industrial and commercial cogeneration energy supply and demand, a comparison of the 1989 projection with previous GRI projections, and a discussion of additional data used in developing the projection. 2 figs., 23 tabs.

21926 **Energy in retrospect: is the past prologue?. .** Weinberg, A.M. (Oak Ridge Associated Universities, Inc., TN (USA)). *Energy Systems and Policy (USA)*, 13(1): 39-50 (1989).

In this analysis, the author argues that energy policy is now obsessed by uncertainty. This has led to an emphasis on control of demand-that is, conservation-and to the increasing of supply in very small increments. This creeping incrementalism, although it finesses uncertainty, could saddle our energy system with high operating costs. Moreover, it may not be adequate to provide the world by 2040 with 6000 nuclear plants, each of 1-GW capacity, that are necessary to avert serious greenhouse warming.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 21336, 21886, 21917, 21918, 21933, 22031, 22550, 22551

21927 (NEB-SS–22-1/1989-11E) **Reasons for decision [in the matter of] Esso Resources Canada Limited, Shell Canada**

Limited, and Gulf Canada Resources Limited. Applications pursuant to part 6 of the National Energy Board Act for Licences to Export Natural Gas. National Energy Board, Ottawa, ON (Canada). Aug 1989. 61p. (CE–02901). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

Three Calgary-based companies applied to the National Energy Board of Canada for licences to export natural gas from the Mackenzie Delta. These are the first applications dealing with major frontier development. Public hearings were held in Ottawa and Inuvik, Northwest Territories and 60 groups and individuals intervened in the proceedings. This report presents the Board's considerations on the application, including the gas supply, markets and gas sales arrangements, transportation, the availability of gas to Canadians, an export impact assessment, and a benefit-cost analysis. In addition, the Board dealt with the possible effect of the unsettled Dene/Metis land claim, and the benefits to Northerners. The Board approved the export of natural gas in the amounts applied for, eventhough there is as yet no pipeline constructed to carry the gas nor are there applications for pipeline approval. However, in conducting the export hearing, the Board did consider the broad issue of the cost of transporting Mackenzie Delta gas, based on estimates filled by the companies for the construction of a hypothetical line down the Mackenzie Valley. 21 tabs.

21928 (NEB-SS–22-1/1989-11F) **Reasons for decision [in the matter of] Esso Resources Canada Limited, Shell Canada Limited, and Gulf Canada Resources Limited. Applications pursuant to part 6 of the National Energy Board Act for Licences to Export Natural Gas.** National Energy Board, Ottawa, ON (Canada). Aug 1989. 66p. (CE–02902). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

Three Calgary-based companies applied to the National Energy Board of Canada for licences to export natural gas from the Mackenzie Delta. These are the first applications dealing with major frontier development. Public hearings were held in Ottawa and Inuvik, Northwest Territories and 60 groups and individuals intervened in the proceedings. This report presents the Board's considerations on the application, including the gas supply, markets and gas sales arrangements, transportation, the availability of gas to Canadians, an export impact assessment, and a benefit-cost analysis. In addition, the Board dealt with the possible effect of the unsettled Dene/Metis land claim, and the benefits to Northerners. The Board approved the export of natural gas in the amounts applied for, even though there is as yet no pipeline constructed to carry the gas nor are there applications for pipeline approval. However, in conducting the export hearing, the Board did consider the broad issue of the cost of transporting Mackenzie Delta gas, based on estimates filled by the companies for the construction of a hypothetical line down the Mackenzie Valley. 21 tabs.

21929 (NEB-SS–22-1/1989-12E) **Reasons for decision [in the matter of] Westcoast Energy Inc. Application dated 14 April 1989 for new tolls effective 1 November 1989.** National Energy Board, Ottawa, ON (Canada). Sep 1989. 65p. (CE–02899). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

In Febuary 1989, the Board informed Westcoast Energy Inc. that it would be holding a public hearing to examine the tolls to be charged by Westcast from November 1 to December 31,1989 an for the 1990 and 1991 test years. This report sets out the Board's considerations and reasons for its decision on toll design and tariff matters, including capacity avaliable for 1990 and 1991 queuing procedures, renewal rights, self-displacement, throughput, promtional tolls for service to the Vancouver Island Project, interruptible and other types of tolls, upstream and downstream diversion, allocation of interruptible capacity, unutilized service credits and unauthorized overrun revenue. The board approved the application, subject to certain conditions.

21930 (NEB-SS–22-1/1989-12F) **Reasons for decision [in the matter of] Westcoast Energy Inc. Application dated 14 April 1989 for new tolls effective 1 November 1989.** National Energy Board, Ottawa, ON (Canada). Sep 1989. 72p. (CE–02900). Available from National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

In Febuary 1989, the Board informed Westcoast Energy Inc. that it would be holding a public hearing to examine the tolls to be charged by Westcast from November 1-December 31,1989 an for the 1990 and 1991 test years. This report sets out the Board's considerations and reasons for its decision on toll design and tariff matters, including capacity avaliable for 1990 and 1991 queuing procedures, renewal rights, self-displacement, throughput, promotional tolls for service to the Vancouver Island Project, interruptible and other types of tolls, upstream and downstream diversion, allocation of interruptible capacity, unutilized service credits and unauthorized overrun revenue. The board approved the application, subject to certain conditions.

2940 Fossil Fuels

Refer also to citation(s) 21161, 21178, 21204, 21319, 21320, 21321, 21365, 21366, 21367, 21904, 21923, 21925, 21927, 21928, 22085, 22087

21931 (CERI–32) **Continental natural gas market: Canadian export capacity in the 90s.** Coad, L.A.; Maerz, D.H. Canadian Energy Research Inst., Calgary, AB (Canada). Oct 1989. 179p. (MICROLOG–90-01034). Available from PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The central issue examined in this study is the level and timing of pipeline capacity additions that will best serve long-term requirements for natural gas trade between Canada and the U.S. A fundamental determinant in the analysis is the resource base believed to exist within the various supply regions in North America. The analysis leads to a number of interesting and significant outcomes for the issues currently facing participants in the North American natural gas market. These findings are divided into those affecting markets in California, the U.S. Midwest, and the U.S. Northeast, and the impacts of alternative resource base assumptions. The report concludes that Canadian consumers may be able to rely on market forces to ensure that their future requirements will be met, since Canadian natural gas exports exhibit considerably more variations across the scenarios examined than does Canadian domestic consumption. However, in order to sustain natural gas exports in the 1.9-2.0 Tcf/yr range, conventional resource discoveries must be in the high end of the current range of expectations and an orderly phase-in of northern supplies must occur around the turn of the century. Increased export capacity will likely lead to increased market competition and prices that increase less rapidly. The Iroquois project, serving mainly the mid-Atlantic market, is well supported by economic forces, although the combined capacity of Iroquois and Champlain to serve New England markets is perhaps too large.

21932 (DOE/FE–0165) **Strategic Petroleum Reserve annual/quarterly report.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Petroleum Reserves. 15 Feb 1990. 35p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008030. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Section 165 of the Energy Policy and Conservation Act (Public Law No. 94-163), as amended, requires the Secretary of Energy to submit annual and quarterly reports to the President and the Congress on activities to develop the Strategic Petroleum Reserve. This report combines the fourth quarter, 1989 Quarterly Report with the 1989 Annual Report. The following topics are discussed: storage facilities development; oil acquisition and transportation; other project activities which include, procurement and contractor support, real estate, environmental compliance and permits, and security; budget and finance; and drawdown and distribution system and vulnerability impact. 9 figs., 8 tabs.

21933 (GAO/RCED–89-104) **Energy regulation: The quality of DOE's oil overcharge information.** General Accounting Office,

Washington, DC (USA). Resources, Community and Economic Development Div. 1989. 7p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

The Economic Regulatory Administration is responsible for resolving oil overcharge cases under the Emergency Petroleum Allocation Act. ERA maintains a case-tracking database that is used primarily to monitor the status of oil overcharge cases. Although the database includes some information on outstanding overcharges, it is not used by ERA management or attorneys to calculate the total overcharge amounts that ERA has alleged or expects to collect. According to the analysis presented in this report, the information is not complete and, in some cases, is known to be inaccurate and not up to date.

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 22085

2960 Electric Power

Refer also to citation(s) 21885, 21887, 21923, 21925, 22075

21934 (DOE/BP–1281) **Draft 1990 Resource Program technical report.** USDOE Bonneville Power Administration, Portland, OR (USA); Bonneville Power Administration, Portland, OR (USA). Dec 1989. 173p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008454. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Resource Program is Bonneville Power Administration's (BPA's) biennial expression of resource actions proposed to meet future loads placed on BPA. The Resource Program also discusses and attempts to resolve resource-related policy issues. BPA uses the 1986 Power Plan (Council's Power Plan) and 1989 Supplement as guidance in looking at the future need for resources and alternative ways of meeting that need. The Resource Program encompasses assessments of resource availability and costs, and analyses of resource requirements and alternative ways of meeting those requirements, through both conservation and generation resources. It translates these general resource conclusions into resource programs for both conservation and generation. These program proposals are inputs to BPA's budget. This Draft, and public comment on it, are the basis for setting resource budgets for Fiscal Years (FY's) 1992 and 1993. 13 refs., 38 figs.

21935 (DOE/BP–1301) **1989 Pacific Northwest loads and resources study: Technical appendix.** Bonneville Power Administration, Portland, OR (USA). Nov 1989. 617p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008455. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The 1989 Pacific Northwest Loads and Resources Study establishes the Bonneville Power Administration (BPA) planning bases for providing an adequate, cost effective, and environmentally sound supply of electricity to BPA customers. BPA's long-range planning incorporates generating resource availability with a range of forecasted electrical consumption. The future electrical demands–firm loads–are subtracted from available resources to determine whether BPA and the region will be surplus or deficit. If resources are greater than loads in any particular year or month, there is a surplus of energy and/or capacity. Conversely, if firm loads exceed available resources, there is a deficit of energy and/or capacity and additional conservation, contract purchases, or generating resources will be needed to meet load growth. This document provides the utility-specific information and technical details that BPA uses to determine the amount of firm surplus energy and capacity that could become available in the Pacific Northwest. This document should be used in conjunction with the 1989 Pacific Northwest Loads and Resources Study, published in November 1989.

21936 (DOE/BP–1329) **Draft Resource Acquisition Approaches Plan: Supplement to draft 1990 resource program technical report.** USDOE Bonneville Power Administration, Portland, OR (USA). Jan 1990. 15p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008445. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The draft 1990 Resource Program proposes that it is time to begin examining alternative approaches, such as competitive bidding, utility-designed programs, and other mechanisms, for acquiring both conservation and generation resources. This Draft Resource Acquisition Approaches Plan is the first step in developing an implementation strategy that describes the alternative approaches (mechanisms) that Bonneville proposes to test. These mechanisms, if approved, will be part of the final 1990 Resource Program covering fiscal years 1992 and 1993.

21937 (DOE/CH/10093–72) **Energy storage and distribution program summary: Volume 1, Overview, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009487. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The United States consumes more electricity today than ever before, despite increases in energy efficiency during the past 35 years. Historically, there has been a direct correlation between energy consumption and the gross national product (GNP). The association is logical, because GNP influences several of the factors that determine electricity consumption. This complex relationship between economic growth and electricity use ties success in the economy to an increase in electricity demand and requires the supply of electricity to be stable and dependable. Projections of both GNP and electricity demand estimate that between now and 2000, the average annual growth rates will be 2%–3%. Providing an adequate supply of electricity could be a problem, however. Projections of electricity supply indicate that by 2000, many regions of the country will experience electrical generating capacity shortages. 14 figs.

21938 (DOE/EIA–0437(88)) **Financial statistics of selected electric utilities, 1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 28 Feb 1990. 1,115p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008781. Available from NTIS, PC A99/MF A01 - GPO - OSTI; GPO Dep.

The Financial Statistics of Selected Electric Utilities publication presents summary and detailed financial accounting data on the electric utility industry. The objective of the publication is to provide the Federal and State governments, industry, and the general public with current and historical data that can be used for policymaking and decisionmaking purposes relating to electric utility issues.

21939 (DOE/PE/79027–T1) **Keystone II project on transmission: 1988 Final summary report.** Keystone Center, CO (USA). [1990]. 12p. Sponsored by U.S. DOE Management & Administration. DOE Contract FG01-87PE79027. Order Number DE90008471. Available from NTIS, PC A03/MF A01 - OSTI.

The ultimate goal of Keystone dialogues is to reach a consensus of opinion on contentious public policy issues. It is not believed that reaching consensus on electricity transmission issues will be easy. However, our experience with past projects has led us to conclude that there is a greater probability of reaching consensus if a core group of individuals continue to participate throughout the process.

21940 (EPRI-CU–6604) **Case studies using WENS-PC and FORECAST MASTER PLUS: Final report.** Ignelzi, P.C. (Pacific Consulting Services, Berkeley, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Pacific Consulting Services, Berkeley, CA (USA). c Feb 1990. 104p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Weather normalization and energy forecasting are two important, perhaps critical, activities electric utilities engage in regularly – whether to satisfy regulatory or internal planning requirements. EPRI has sponsored the development of two software products, WENS-PC and FORECAST MASTER PLUS, to facilitate the performance of these activities. This report demonstrates the applicability and application of these two products to problems commonly faced by utility analysts responsible for the preparation of short-run electricity sales and load forecasts and adjustments to past sales to account for the effects of so-called non-normal weather. The volume contains theoretical discussions with sample applications and a discussion about the procedure for performing

weather normalization, in addition to descriptions and results of three case studies, at New England Power Service Company, City of Colorado Springs, and Potomac Electric Power Company, performed by utility analysts. 11 refs., 46 figs., 15 tabs.

21941 (EPRI-CU–6605, pp. 24.1-24.10) **Market penetration potential of new clean coal technologies.** Veselka, T.D.; Rose, K. Electric Power Research Inst., Palo Alto, CA (USA); Edison Electric Inst., Washington, DC (USA); Synergic Resources Corp., Bala-Cynwyd, PA (USA). [1989]. (CONF-8906176–: Utility opportunities for new generation, Boston, MA (USA), 28-30 Jun 1989). In *Utility opportunities for new generation.* Order Number DE90005297. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Clean Coal Technology Demonstration Program, a $5 billion national commitment to demonstrate economic and environmentally sound methods for utilizing the nation's vast coal resources, is fostering the further development of coal technologies for future commercialization. The program, which is cost-shared by the federal government and the private sector, has spawned proposals for demonstrating technologies that range from SO_2-scrubbing systems for coal-burning cement kilns to coke oven gas cleaning to advanced integrated gasifier combined-cycle (IGCC) units for electric generation. Although the program accepts proposals from all sectors of the economy, thus far most proposals have been from the electric utility sector, which has historically accounted for over 90% of the nation's coal consumption. Once these technologies are ready for commercialization, their adoption by industry will depend on a number of considerations. This paper describes some of the factors that will influence the market penetration of clean coal technologies and presents results from a model that simulates electric utility capacity expansion. 20 refs., 8 tabs.

21942 (EPRI-CU–6632) **The performance potential of local and distributed load controllers: Final report.** Isaken, L. Electric Power Research Inst., Palo Alto, CA (USA); BRI Systems, Inc., Glendale, AZ (USA); Analysis and Control of Energy Systems, Inc., Burlingame, CA (USA). c Mar 1990. 166p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Many utilities are considering demand control as a way to reduce the need for new facilities and to use existing equipment more efficiently. It is usually believed that local and distributed demand controllers are effective in reducing the peak demands of individual customers. But considerable controversy remains in the industry as to whether the benefits to the utility are adequate to justify the incentive payments to customers. This study addressed the impacts of demand controllers on utilities and their customers in order to better understand them, and to identify desirable equipment characteristics and operating strategies.

21943 (LBL–27114) **Residential end-use load shape data analysis: Final report.** Ruderman, R.; Eto, J.H.; Heinemeier, K.; Golan, A.; Wood, D.J. Lawrence Berkeley Lab., CA (USA). Apr 1989. 114p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008045. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Reliable data on end-use load shapes are important for forecasting electricity demand in least-cost utility planning. This report analyzes available residential end-use metered data collected by California utilities to use with an electricity peak demand forecasting model developed by the California Energy Commission. Representative daily load shapes for four seasons are developed for seven residential non-space-conditioning end uses. Hourly energy use for space conditioning end uses (central air conditioning and room air conditioning) is modeled with matrices that express energy use as a function of time of day, temperature and humidity. Exploratory work to represent these matrices with analytic functions is also presented. 17 refs., 25 figs., 20 tabs.

21944 (LBL–27512) **Integrated estimation of commercial sector end-use load shapes and energy use intensities: Final report.** Akbari, H.; Eto, J.; Turiel, I.; Heinemeier, K.; Lebot, B.; Nordman, B.; Rainer, L. Lawrence Berkeley Lab., CA (USA). Jan 1989. 275p. Sponsored by California Energy Commission; U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008073. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

The Southern California Edison Company (SCE) and the California Energy Commission (CEC) have contracted with the Energy Analysis Program of the Applied Science Division at the Lawrence Berkeley Laboratory (LBL) to develop an integrated set of commercial sector load shapes (LS) and energy utilization indices (EUI) for use in forecasting electricity demand. The objectives of this project are to conduct detailed analyses of SCE data on commercial building characteristics, energy use, and whole-building load shapes; and in conjunction with other data, to develop, test, and apply an integrated approach for the estimation of end-use LSs and EUIs. The project represents one of the first attempts to combine simulation-based, prototypical building analyses with direct reconciliation to measured hourly load data. The project examined electricity and gas use for nine building types, including large offices, small offices, large retails, small retails, food stores, sitdown restaurants, fastfood restaurants, refrigerated warehouses, and non-refrigerated warehouses. For each building type, nine end uses were examined, including cooling, heating, ventilation, indoor lighting, outdoor lighting, miscellaneous equipment, water heating, cooking, and refrigeration. For the HVAC end uses (cooling, ventilation, and heating), separate analyses were performed for three climate zones: coastal, inland, and desert.

21945 (LBL–27764) **Plans for the power sector in thirteen major developing countries.** Meyers, S.; Sathaye, J.; Masera, O.; Ketoff, A. Lawrence Berkeley Lab., CA (USA). Oct 1989. 120p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008057. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report presents an overview of plans for the power sector in the 1990s in 13 major developing countries. Together, these 13 countries account for about 72% of total developing country electricity production. For each country, we present (1) background information on the power sector, (2) estimates of resources available for electricity generation, (3) official forecasts of electricity demand, (4) current or recent plans for expansion of generating capacity through the year 2000, (5) discussion of financial and environmental issues and supply and end-use efficiency, and (6) a brief analysis of the stated plans for the power sector.

21946 (ORNL/CON–298) **Assessing integrated resource plans prepared by electric utilities.** Hirst, E. (Oak Ridge National Lab., TN (USA)); Schweitzer, M.; Yourstone, E.; Eto, J. Oak Ridge National Lab., TN (USA). Feb 1990. 41p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90008078. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses guidelines for long-term resource plans, based on the written reports only. The word plan refers to both the program worked out beforehand to accomplish a goal and the report that describes the plan. The particular meaning should be clear from the context. The purpose of these guidelines is to assist PUC staff who review utility plans and utility staff who prepare such plans. These guidelines were developed at Oak Ridge National Laboratory with contributions from Lawrence Berkeley Laboratory. 45 refs.

21947 (ORNL/FTR–3536) **[Rural electrification: Grid extension, decentralization, and financing]: Foreign trip report, January 28, 1990–February 9, 1990.** Perlack, R.D. Oak Ridge National Lab., TN (USA). 22 Feb 1990. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90007572. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

H.G. (Mike) Jones and I had numerous meetings with EEGSA staff. We discussed rural electrification plans, reviewed documents, and collaborated on collecting information on decentralized energy alternatives. Meetings were also held with USAID/Guatemala, USAID/ROCAP, NRECA, MEM, PVOs, and equipment vendors. A preliminary draft report and spreadsheet for comparing decentralized power alternatives was completed. The report and findings were presented to EEGSA and the methodology transferred to

EEGSA staff. A set of recommended followup activities was also presented to EEGSA.

21948 Data requirements for utility integrated resource planning. Hirst, E. (Oak Ridge National Lab., TN (USA)). *Energy Systems and Policy (USA)*, 12(4): 219-232 (1988). DOE Contract AC05-84OR21400.

Integrated resource planning requires electric utilities to assess carefully and comprehensively a broad array of demand and supply alternatives. Data and assumptions on these resources and on the utility's external environment are required, both to compare resources and to test diverse resource portfolios against various uncertainties. This review of available data concludes that much more information is available on supply resources than on demand-side management programs. This disparity exists because utilities have had substantially more experience with the construction and operation of power plants than with the design and administration of conservation and load-management programs. However, demand-side programs have inherent uncertainty-reducing features that makes them attractive to utilities.

2980 Consumption and Utilization

Refer also to citation(s) 21161, 21935, 21942, 21943, 21944

21949 (EPRI-CU-6746) **Efficient electricity use: Estimates of maximum energy savings: Final report.** Faruqui, A.; Mauldin, M.; Schick, S.; Seiden, K.; Wikler, G.; Gellings, C.W. Electric Power Research Inst., Palo Alto, CA (USA); Barakat and Chamberlin, Inc., Oakland, CA (USA). c Mar 1990. 88p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The dual concerns about global warming and electricity supply shortages have heightened interest in efficient energy technologies. EPRI initiated this study to develop estimates of the maximum technical potential energy savings. The study result shows that if by the year 2000 the entire stock of electric end use were to be replaced with the most energy efficient electric end-use technologies, the maximum energy savings could range from 8000 to 14400 trillion BTUs, or 24 to 44% of electric energy consumption. Also, the substitution of efficient electric end use to replace fossil fuel in several major applications in the industrial and transportation sectors can realize a potential net fossil fuel saving of 363 trillion BTUs in the year 2000.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 21590, 21591, 21636

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

21950 (DOE/ET/15601-32) **Diagnostic development and support of MHD [magnetohydrodynamics] test facilities: Technical progress report, January, February, March 1988.** Mississippi State Univ., Mississippi State, MS (USA). MHD Energy Center. Apr 1988. 36p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-80ET15601. Order Number DE90005964. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Mississippi State University is developing diagnostic instruments for MHD power train acquisition and for support of MHD component development test facilities. Microprocessor-controlled optical instruments, initially developed for HRSR support, are being refined, and new systems to measure temperatures and gas-seed-slag stream characteristics are being developed. To further data acquisition and analysis capabilities, the diagnostic systems are being interfaced with MHD Energy Center computers. Technical support for the diagnostic needs of the national MHD research effort is being provided. MSU personnel will also cooperate with government agencies and private industries to improve the transformation of research and development results into processes, products and services applicable to their needs. 4 figs., 1 tab.

21951 (DOE/ET/15601-35) **Diagnostic development and support of MHD [magnetohydrodynamics] test facilities: Technical progress report, October, November, December 1988.** Mississippi State Univ., Mississippi State, MS (USA). Diagnostic Instrumentation and Analysis Lab. Jan 1989. 62p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-80ET15601. Order Number DE90004969. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Mississippi State University is developing diagnostic instruments for MHD power train data acquisition and for support of MHD component development test facilities. Microprocessor-controlled optical instruments, initially developed for HRSR support, are being refined, and new systems to measure temperatures and gas-seed-slag stream characteristics are being developed. To further data acquisition and analysis capabilities, the diagnostic systems are being interfaced with MHD Energy Center computers. Technical support for the diagnostic needs of the national MHD research effort is being provided. MSU personnel will also cooperate with government agencies and private industries to improve the transformation of research and development results into processes, products and services applicable to their needs. 5 refs., 21 figs., 1 tab.

21952 (DOE/ET/15601-36) **Diagnostic development and support of MHD [magnetohydrodynamics] test facilities: Technical progress report, January, February, March 1989.** Mississippi State Univ., Mississippi State, MS (USA). Diagnostic Instrumentation and Analysis Lab. Apr 1989. 46p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-80ET15601. (FE-15601-36). Order Number DE90007171. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Mississippi State University is developing diagnostic instruments for MHD power train data acquisition and for support of MHD component development test facilities. Microprocessor-controlled optical instruments, initially developed for HRSR support, are being refined, and new systems to measure temperatures and gas-seed-slag stream characteristics are being developed. To further data acquisition and analysis capabilities, the diagnostic systems are being interfaced with MHD Energy Center computers. Technical support for the diagnostic needs of the national MHD research effort is being provided. MSU personnel will also cooperate with government agencies and private industries to improve the transformation of research and development results into processes, products and services applicable to their needs. 10 figs., 1 tab.

21953 (DOE/ID/12735-T6) **[Manage, operate and maintain the Component Development and Integration Facility in Butte, MT]: Quarterly technical progress report, October 1-December 31, 1989.** MSE, Inc., Butte, MT (USA). [1989]. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-88ID12735. Order Number DE90008278. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This quarterly technical progress report presents the tasks accomplished at the Component Development and Integration Facility during the first quarter of FY90. Areas of technical progress this quarter included: coal system development; seed system development; test bay modification; channel power dissipation and distribution system development; integrated topping cycle/proof-of-concept current controls project; split coal feed system; iron core magnet thermal protection system checkout; combustion carbon balance and stack gas analysis; coal-fired combustor support; 1A channels fabrication and assembly; arc observation project; support of Mississippi State University diagnostic testing; test operations and results; data enhancement; data analysis and modeling; technical papers; and projected activities. 2 tabs.

21954 (IAE-2062/E-3/PP/B) **The analysis of the influence of the current regulation on the parameters of the MHD-genarator Faraday's type and on the mutual work of the generator and electric power network.** Dabrowski, K. Institute of Atomic Energy, Otwock-Swierk (Poland). Jul 1988. 29p. (In Polish). Order Number DE90619016. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Received in 1989.

This paper contains: comparison of the influence of the I=const. and U=const. regulation on the gasdynamic characteristics of the MHD-generator Faraday's type with segmented electrodes, comparison of the influence of the I=const. and U=const. regulation on choice of the compressor which causes the gas flow in the MHD generator, analysis of the influence of the I=const. regulation on the mutual work of the MHD-generator and electric power network in nonsteady states caused by the stagnation temperature drop at the MHD-duct inlet. In the work was assumed: one dimensional mathematical model of the MHD-generator, mathematical model of the inverter was constructed by means of the "zero-one" model of the thyristor, multichannel, synchronous control system of the inverters, inflexible electric power network. 12 refs., 11 figs., 2 tabs. (author).

21955 Expectations for the Laguna foil implosion experiments. Greene, A. (Los Alamos National Lab., NM (USA)); Brownell, J.; Caird, R.; Goforth, J.; Price, R.; Trainor, J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors discuss the Laguna foil implosion experiments. In this series, a Mark-IX helical generator will be coupled to an explosively formed fuse opening switch, a surface tracking closing switch, and a vacuum power flow and load chamber. In this paper the system design is discussed and results from zero-, one-, and two-dimensional MHD simulations are presented. The authors anticipate that the generator will provide more than 10 MA of which ~5.5 MA will be switched to the 5-cm-radius, 2-cm-high, 250-nm-thick aluminum foil load. This should give rise to a 1 μs implosion with more than 100 kJ of kinetic energy.

3005 Fuel Cells

21956 (DOE/MC/24222–2790) **Advanced on-site power plant development technology program: Final report.** International Fuel Cells Corp., South Windsor, CT (USA). Sep 1989. 251p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-82MC24222. Order Number DE90000443. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

The subject contract was initiated in August 1982 and the technical effort concluded in April 1989. The purpose of the technical effort was to establish a technology base for 200-kW on-site fuel cell power plants. It was conducted in two phases: (1) Component evaluation; and (2) Full-scale system verification. This contract was supplemented by a Gas Research Institute (GRI) contract which was conducted in the 1981–1986 time period. This GRI contract concentrated on 200-kW scale component design, thermal management/water treatment system analysis and redesign and advanced DC/AC inverter development. The component evaluation phase generally included subscale component tests, scale-up to full-size 200-kW hardware and full-size hardware tests of the cell stack (in Tasks 1 and 2), the power conditioner (in Task 3), the heat exchangers and ancillary components (in Task 4), and the fuel processor (in Task 5). The full-size cell stack, fuel processor, heat exchangers, and ancillary components from the component development tasks were integrated into a dc system called the Verification Test Article (VTA). The VTA which was fabricated and tested under Task 7 allowed for system integration issues associated with the cell stack, fuel processor, thermal management, and water treatment subsystems to be explored under conditions similar to an actual fuel cell power plant. Key accomplishments of this contract are described. 193 figs., 37 tabs.

21957 (N–90-13718) **Modern biofuel cells for waste recycling in life support systems. Final report.** Chen, L.; Bockris, J.O. Texas A and M Univ., College Station, TX (USA). Sep 1989. 44p. (NASA-CR–185963;NAS–1.26:185963). Available from NTIS, PC A03/MF A01.

Innovative ways of treating urea in waste water reprocessing for long duration space exploration are being considered. Urea is very stable and therefore there are few effective ways for its decomposition. The feasibility of the use of the enzyme urease is to catalyze the hydrolysis of urea to ammonia and carbon dioxide is discussed, including a methodology, potential problems, the capabilities and advantages of such a system.

21958 (PB–90-131293/XAB) **Development of planar-geometry solid oxide fuel-cell technology: Phase 2. Annual report, October 1987-October 1988.** Khandkar, A.C.; Prouse, D.W.; Elangovan, S. Ceramatec, Inc., Salt Lake City, UT (USA). Feb 1989. 100p. (PROG–8860710). Available from NTIS, PC A05/MF A01.

See also PB–90-100769.

This report documents the progress made towards the development of planar-geometry SOFC technology. The thrust of the effort was to develop stack technology via the development of planar-ribbed interconnects, and to demonstrate improved cell performance. The problem related to anode adhesion and delamination during cell operation was addressed using alternate materials as well as by developing optimized processes. In addition, the cell performance was optimized iteratively. Successful single cell tests conducted demonstrated an improved cell performance of 300 mA/sq cm at 0.5V using different anode gas compositions. In addition, the edge seal material was qualified in both out-of-cell and in-cell tests to be adequate for a cumulative cell test time of over 1000 hrs. Cell diagnostic techniques were developed for out-of-cell component qualification. Diagnostic tests conducted on single cells indicate that the major polarization loss occurs at the anode. Interconnect materials were synthesized, characterized, and pressureless sintered in air. Problems encountered with densification were solved using transient liquid-phase densification aids and controlled atmosphere and pressure while sintering.

21959 (PNL-SA–16902) **Alternative materials for solid oxide fuel cells.** Bates, J.L.; Chick, L.A.; Rieke, P.C.; Weber, W.J. Pacific Northwest Lab., Richland, WA (USA). May 1989. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC06-76RL01830. (CONF-890572–2: 1. annual fuel cells contractors review meeting, Morgantown, WV (USA), 2-4 May 1989). Order Number DE90008615. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This project is an effort to modify state-of-the-art Solid Oxide Fuel Cells (SOFC) materials or develop analogous SOFC materials as electrodes and interconnections that will provide improved electrical, thermal expansion and electrochemical properties. Work includes four tasks: material synthesis and processing technology in order to modify alternative interconnection materials (powders) that can be sintered in air below 1823 K with and without the use of metal additives as sintering aids; evaluation of additive effects on structure, synthesis and electrical and thermal properties of alternative interconnection materials of based of $La(M')(Cr, M")O_3$ and $Y(M')(Cr,M")CrO_3$; evaluation of electrical and thermal properties of alternative interconnection of materials as functions of composition, structure and synthesis/fabrication methods; and electrochemical behavior of material interfaces is being studied to evaluate simple SOFC geometries. 1 ref., 2 figs.

3008 Miscellaneous Converters

21960 (AD-A–214919/3/XAB) **Plasma accelerator and energy-conversion research. Final report, 4 May 1982-31 October 1982.** Pawlik, E.V. Jet Propulsion Lab., Pasadena, CA (USA). 29 Oct 1982. 39p. Available from NTIS, PC A03/MF A01.

The tasks were: 1. To construct by magnetron sputter deposition three AMTEC porous electrodes of 1-3 micrometers thickness, one of LaB6 on a beta'-alumina solid electrolyte tube, and two of molybdenum-titanium alloy, one of which shall be in the range of 0.2% - 0.5% titanium and the other in the range of 0.5% - 5% titanium. 2. To characterize the morphology and composition of the deposited electrodes before and after high-temperature operation and sodium electrolysis by scanning electron microscopy and ion microprobe chemical analysis. 3. To investigate the electrochemical performance and measure sodium-vapor transport properties of the deposited electrodes by determining current-voltage characteristics and by current-interrupt measurements. A current-interrupt test circuit was to be designed and assembled for this purpose. 4. To

analyze electrode performance in terms of chemical and morphological characteristics and the relation of these characteristics to electrochemical processes at the beta'-alumina interface and sodium flow characteristics.

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Refer also to citation(s) 21892

3201 Buildings

Refer also to citation(s) 21587, 21615, 21616, 21625, 21889, 22041, 22046, 22071, 22174, 22251, 22506, 22527, 23199

21961 (AMA–89-06294) **Caribbean export home.** Martin, T.D. Alberta Municipal Affairs, Edmonton, AB (Canada). Innovative Housing Grants Program. Dec 1988. 47p. (MICROLOG–89-06294). Available from PC Innovative Housing Grants Program, Research and Development Section / Housing Division, 16th Floor, Citycentre, 10155 - 102 Street, Edmonton, AB, CAN T5J 4L4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An Alberta company has developed a stressed skin, foam-filled panel system for the factory-manufactured, site-assembled, small structures industry. The system provides a fast, precise method of building energy efficient houses, as well as commercial and agricultural buildings. The basic system is a stressed skin load bearing panel having a continuous header, base, and top and bottom plates. The panel is very stiff and can be used vertically, horizontally, or on a slope. The panels are filled with polyurethane foam to provide a R-28 insulation value using a 100 mm thick panel. The continuous header permits the future installation of windows and doors in almost any location without installing additional headers. The system offers significant advantages including ease and speed of installation, precise sizing with no shrinking, warping or twisting, high insulation value, higher strength than conventionally framed walls, and ease of transport. A demonstration project was arranged with a joint venture partner in Antigua to build two demonstration houses for evaluation and market modelling purposes. The houses were designed and manufactured in Alberta, and shipped to the Antigua job site where they were erected by local labor. After encountering delays and problems which were eventually overcome, the houses were successfully completed. Sufficient orders were received for new houses that the Alberta company relocated to a larger and more efficient plant facility. 23 figs., 1 tab.

21962 (BRE-IP–20/89) **An energy-efficient refurbishment of electrically heated high-rise flats.** Ward, D.D. Building Research Establishment, Watford (UK). Nov 1989. 3p. Order Number DE90754402. Available from NTIS (US Sales Only), PC A02/MF A01.

This paper describes the results and lessons learned from the extensive monitoring of two blocks of high-rise flats which had a comprehensive package of energy efficiency measures included as part of a major refurbishment programme. It is addressed to architects, engineers, housing officers and tenants in housing authorities, housing associations and other bodies concerned with the maintenance and refurbishment of high-rise blocks. (author).

21963 (DOE/BP–1323) **Final radon testing results for the Residential Standards Demonstration Progam.** Reiland, P.F.; Johnson, M.E.; Thor, P.W. USDOE Bonneville Power Administration, Portland, OR (USA). Office of Energy Resources. Dec 1989. 51p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008462. Available from NTIS, PC A04/MF A01 - OSTI.

This report summarizes radon concentrations in indoor air measured in occupied residential dwellings in the Pacific Northwest. The dwellings are part of the Bonneville Power Administration's (BPA) Residential Standards Demonstration Program (RSDP). Construction costs, thermal performance, and indoor air quality effects of the Model Conservation Standards (MCS) were studied. Construction costs were being studied using detailed cost accounting obtained from the builder of the MCS dwelling and a hypothetical equivalent dwelling built to current practice. Thermal performance was assessed using weekly summaries of submetered space and water heating energy. Indoor air quality was studied using a fan pressurization infiltration test. 11 refs., 21 figs., 11 tabs.

21964 (DOE/BP–1326) **Research projects in residential technology.** Paglin, C.; Thor, P. Bonneville Power Administration, Portland, OR (USA). Dec 1989. 27p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008450. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This booklet provides a brief description of both completed and ongoing research and development projects assigned to the Residential Technology Section. It describes the objective and results of each completed project along with a report title and contact person. For ongoing projects, the objective, the anticipated results, the anticipated completion date, and a contact person are provided. Older reports and Technical and Administrative Updates are merely listed without a description.

21965 (DOE/BP/23821–2) **Modular housing case study: Residential Construction Demonstration Project.** USDOE Bonneville Power Administration, Portland, OR (USA); Washington State Energy Office, Olympia, WA (USA). Oct 1989. 32p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC79-85BP23821. Order Number DE90008456. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Residential Construction Demonstration Project (RCDP) was designed as an innovative conservation strategy for the Pacific Northwest. Its primary objective was to increase the capacity of the homebuilding industry to provide cost effective energy efficient housing to the region. Modular housing was included under RCDP as an innovative energy efficient construction technology. Modular builders were encouraged to construct homes that met the Super Good Cents requirements. Regional manufacturers were offered training, design and construction assistance in return for labor and material cost information. Nine homes were built under the RCDP. Digital submeters were installed in each home to monitor space and water heating energy use. Air infiltration tests were also included in the test data. The report concludes that the modular housing industry can meet the technical requirements for Super Good Cents construction. Design and production changes were within the industries capabilities as well.

21966 (DOE/BP/34625–1) **Northwest residential infiltration study: Volume 1, Analysis and results.** Palmiter, L. (Ecotope, Inc., Seattle, WA (USA)); Brown, I. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Ecotope, Inc., Seattle, WA (USA). Jan 1990. 52p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC79-82BP34625. Order Number DE90008475. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Air infiltration is a major source of heat loss in residential buildings; in modern well-insulated homes, air infiltration may account for as much as half of the total heat loss. It is also an important factor affecting indoor air quality. This report summarizes the final results of a major study of air infiltration rates in new, electrically heated homes located in the Pacific Northwest. This report is one of two which summarize the project. The companion volume, "NORIS: Sample Selection and Bias Assessment" [Palmiter and Brown 1989] presents the results of the initial telephone survey, the selection of the sample, and a statistical assessment of potential selection bias in the sample. 15 refs., 14 figs., 20 tabs.

21967 (DOE/BP/34625–2) **Northwest residential infiltration study: Volume 2, Sample selection and bias assessment.** Palmiter, L. (Ecotope, Inc., Seattle, WA (USA)); Brown, I. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Ecotope, Inc., Seattle, WA (USA). Jan 1990. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC79-82BP34625. Order Number DE90008453. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Air infiltration is a major source of heat loss in residential buildings. It is also an important factor affecting indoor air quality.

Previous studies sponsored by the Bonneville Power Administration produced conflicting results for infiltration rates. The Northwest Residential Infiltration Survey (NORIS) was intended to shed additional light on the magnitude of air infiltration in new electric-heat homes in the Bonneville service area. Both the heat loss and indoor air quality impacts were to be addressed, as well as a comparison of two different measurement technologies. The study was to be both scientifically and statistically defensible. This report describes the study design and sample selection process used in the NORIS project. This work was carried out under contract to the Washington State Energy Office and Battelle Pacific Northwest Laboratories. This report focuses on the sample selection process and bias assessment; a discussion of the many technical and scientific issues which were simultaneously considered is discussed in the companion report to this, entitled "NORIS: Analysis and Results."

21968 (DOE/CE/15434–T1) **Modular apparatus for laundry dryer heat recovery: Technical progress report.** Herschel, B.B. Rototherm, Inc., Howell, NJ (USA). 10 Mar 1990. 4p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15434. Order Number DE90008469. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. CLOTHES DRYERS/heat recovery; PROGRESS REPORT; APPLIANCES; DEMONSTRATION PROGRAMS; COMMERCIALIZATION; ENERGY CONSERVATION

21969 (DOE/OR/00033–T431) **A method for estimating annual dose equivalent to the lung under varying radon progeny conditions.** Pope, J.S. Oak Ridge Associated Universities, Inc., TN (USA). 1989. 54p. Sponsored by U.S. DOE Energy Research; Oak Ridge Associated Universities. DOE Contract AC05-76OR00033. Order Number DE90007742. Available from NTIS, PC A06/MF A01 - OSTI.

Thesis. Submitted to Univ. of North Carolina, Chapel Hill.

The purpose of this project is to present a simple and specific method to assess the radon progeny hazards in the home and to apply this method. In order to determine the lung dose for any age individual and particle size distribution, this research developed equations using a lung model by D. Crawford-Brown. These equations may be used to estimate annual lung dose from information concerning the radon progeny concentration, unattached fraction, and aerosol size distribution. Measurements of radon and radon progeny were performed in two upstate New York homes which were identified as having potentially elevated radon concentrations. Sampling procedures for unattached fractions were applied to obtain the necessary parameters for the lung dose calculations. Estimates of lung dose equivalent to the subsegmental bronchioles for the two families were calculated from these specific measurements, with the assumption of a typical particle size distribution. Therefore, a method both for sampling radon progeny and for calculating lung dose to various groups under differing particle size distributions and unattached fractions is presented. 23 refs., 14 figs., 8 tabs.

21970 (EPRI-CU–6686) **Development and application of a uniform testing procedure for griddles: Final report.** Saltmarch, M. (San Jose State Univ., CA (USA). Dept. of Nutrition and Food Services). Electric Power Research Inst., Palo Alto, CA (USA); Pacific Gas and Electric Co., San Ramon, CA (USA); San Jose State Univ., CA (USA). Dept. of Nutrition and Food Services. c Dec 1989. 89p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This research report compares the performance of two single-sided, thermostatically controlled gas griddles when tested in accordance with a Uniform Testing Procedure (UTP) developed by the contractor, Pacific Gas and Electric Company (PG&E). Variables reported for each griddle include preheat time and energy consumption, idle-energy consumption, cooking-energy consumption, cooking capacity, cooking-energy efficiency, water-boil efficiency, and the temperature uniformity of the cooking surface. The application of synthetic food models, as a test food alternative to hamburger patties, was investigated. The energy performance of the griddles when tested under controlled, laboratory-style conditions is compared to the performance of the same griddles used for menu production at PG&E's Learning Center in San Ramon, California. The UTP for griddles developed in this research project is documented in this report. The UTP has been submitted to the ASTM Committee F-26 on Food Service Equipment for consideration as an official ASTM Test Method.

21971 (EPRI-CU–6690-Vol.2) **Detailed field evaluation of a cold air distribution system: Volume 2, Graphical data: Final report.** Dorgan, C.E. (Dorgan Associates, Inc., Madison, WI (USA)); Elleson, J.S.; Downey, M.S. Electric Power Research Inst., Palo Alto, CA (USA); Dorgan Associates, Inc., Madison, WI (USA). c Feb 1990. 153p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A cold air distribution system on a typical floor of a 12-story office building in southern California was instrumented, and detailed data were collected for a 7-month period. The system was designed to supply 45°F-49°F primary air from an ice storage cooling system. It was found that supply fan energy was 38% less than for a conventional 55°F supply air system. However, the energy consumption of the continuously operating fan-powered mixing boxes of the system, with their relatively inefficient fractional-horsepower motors and small fans, offsets the supply fan energy savings. Energy consumption was calculated for several alternative approaches to supply air mixing and distribution, and recommendations for needed research are given. Volume 1 contains descriptions of the system and the monitoring approach, and results and conclusions. Complete data are provided in graphical form in Volume 2.

21972 (EPRI-CU–6739) **Pilot study of commercial water-loop heat pump compressor life: Final report.** Ross, D.P. (Policy Research Associates, Inc., Reston, VA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Policy Research Associates, Inc., Reston, VA (USA). c Mar 1990. 55p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This study of the service life of water-loop heat pump compressors in commercial office buildings, using data gathered from the service records of one heat pump service contractor, focused on the replacement of compressors in small console ("perimeter") water-loop heat pumps and in larger vertical and horizontal ("core") units. A statistical methodology for dealing with censored data was developed for this study which is an extension of the methodologies used in other EPRI studies of heat pump and heat pump compressor life. By extrapolating a Weibull distribution curve fitted to the data, the median service life of the sample of perimeter unit compressors (the age at which 50% of the original population of compressors would be expected to have been replaced) was estimated to be 47 years. The median service life of a sample that excluded compressors with a known manufacturing defect was estimated to be 69 years. Core unit compressor replacements were analyzed in the same manner. Extrapolation of a Weibull distribution yielded an estimated median service life of core unit compressors of 12 years. As with the perimeter unit compressors, there was an identified manufacturing defect. When the compressors with the identified fault were excluded from the sample and the data reanalyzed, the median service life for the compressors in the remainder of the buildings was estimated to be 18 years.

21973 (GKYA–89-06355) **Development of a computer model to predict overheating in passive solar houses.** Yuill (G.K.) and Associates Ltd., Winnipeg, MB (Canada). 29 May 1987. 55p. Contract EMR 48SZ23216-6-6255. (MICROLOG–89-06355). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A simple technique to calculate the monthly degree of overheating for a building from monthly average data has been developed. Overheating has been defined as the energy required per unit area to maintain a building below a specified temperature. Overheating for realistic building models was calculated by finding overheating for zero thermal mass buildings, and using a utilization factor to determine the effect of thermal mass on overheating. This utilization factor was related to the available energy for cooling stored in the mass and to the zero thermal mass cooling loads. A simple lumped capacitance hour-by-hour heat balance model was used to develop correlations for the utilization factor. Agreement between

the hour-by-hour model and the model developed was excellent, with approximately 5% error. Comparison of the above models was made with BLAST, a complex hourly building load analysis program. Agreement was very good, with an average error for the daily model in the order of 10%, and an RMS deviation of 15.6 kWh/month. A shading model has been developed to improve the suitability of the overheating model for inclusion in HOTCAN. Calculation of shading on the east and west sides of a building, as well as shading by overhangs that extend below the top of a window, such as awnings has been added. Comparison of this model for south side shading to the Balcomb model used in HOTCAN show good agreement, with the largest deviation 5.7%, and an RMS deviation of 2.2%. 10 refs., 14 figs., 6 tabs.

21974 (HME–90-01164) **Assessment of cost effectiveness of R-2000 energy measures in the prairies.** Mayhew, W.J. Howell Mayhew Engineering, Inc., Edmonton, AB (Canada). Aug 1989. 107p. (MICROLOG–90-01164). Available from PC Innovative Housing Grants Program, Reserach and Development Section / Housing Division, 16th Floor, Citycentre, 10155 - 102 Street, Edmonton, AB, CAN T5J 4L4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This report presents the results of an analysis of the actual costs of energy conservation measures and related building components used under the R-2000 program, determines the cost effectiveness of energy conservation measures, assesses the results and describes the differences in construction practices and incremental costs for local conditions, and makes recommendations, on a regional basis, on appropriate energy conservation techniques. The actual costs of R-2000 energy conservation measures and related building components were determined by examining recent costs reported by experienced R-2000 builders in Alberta, Saskatchewan, and Manitoba on a selected sample of R-2000 houses. Energy consumption values were predicted using the HOT-2000 Energy Analysis Program. In addition, the actual R-2000 house designs were optimized using the HOT-2000 computer program to minimize incremental costs and maximize cost effectiveness. The resulting data were tabulated, assessed and used to develop recommendations. The report concludes that, where higher efficiency natural gas heating appliances are used, with R-20 basement walls and careful air sealing and HRV, simple payback periods of 2-10 years can be achieved for all 3 provinces. Several typical R-2000 components such as exterior walls greater than R-20, attic insulation greater than R-50 and higher performance windows were shown not to be cost effective upgrades.

21975 (IEA-HPC-WR–2) **Proceedings of the workshop on ground-source heat pumps.** Calm, J.M. (ed.). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. 262p. (CONF-8610224–:). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

A workshop on ground-source heat pumps was conducted to examine their status, benefits, and opportunities. The speakers and other participants were selected from Canada, Germany, the Netherlands, Sweden, Switzerland, and the United States to enable an international exchange of ideas. A key topic of the meeting was identification of research and development needs, for which the principal results are presented. (orig.).

21976 (IEA-HPC-WR–2, pp. 1-10) **Ground-source heat pump workshop summary.** Calm, J.M. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–: Workshop on ground-source heat pumps, Albany, NY (USA), 27 Oct - 1 nov 1986). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

A workshop on ground-source heat pumps was conducted to examine their status, benefits, and opportunities. The speakers and other participants were selected from Canada, Germany, the Netherlands, Sweden, Switzerland, and the United States to enable an international exchange of ideas. A key topic of the meeting was identification of research and development needs, for which the principal results are presented. (orig.).

21977 (IEA-HPC-WR–2, pp. 11-19) **System configurations.** Calm, J.M. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Three types of ground-source heat pump (GSHP) systems are used: Groundwater, ground-coupled, and direct-expansion. The first two use water for intermediate transport of heat from the ground. In groundwater systems, water is removed from underground, though often reinjected later. In ground-coupled systems, a closed loop or loops of recirculated fluid (usually water with glycol or brine) is or are used to couple the heat pump to the ground. For direct-expansion systems, refrigerant is actually circulated in a buried heat exchanger. Many different heat exchanger designs are in use for ground-coupled and direct expansion systems, and new ones are being developed to reduce system costs. This paper provides an overview of GSHP system configurations, discusses relative benefits and disadvantages, and describes a number of system options including integrated water heating. (orig.).

21978 (IEA-HPC-WR–2, pp. 27-34) **The European market.** Mogensen, P. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Heat pump heating systems in Europe normally use a hydronic distribution system and are generally heating only systems combined with an oil-fired boiler. The ground is the most popular heat source. Market factors which have led to these systems are described. Climate, social concerns, and fuel costs are the more important factors identified. Ground source heat pumps (GSHP) in Europe are more expensive than U.S. systems. Information on the number of GSHP installations in various European countries is presented showing wide variations between them. (UA).

21979 (IEA-HPC-WR–2, pp. 35-45) **Perspectives of a major air-source heat pump manufacturer.** Crawford, J.G. (Trane Co., La Crosse, WI (USA)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper presents the views of an air-source heat pump (ASHP) manufacturer on the subject of ground-source heat pumps (GSHP). The attractiveness of the GSHP in comparison to an alternative system depends upon cost, capacity, efficiency, location, service life, and factory U.S. field erection. In general GSHPs are more expensive due to the costs of the ground collector and are less efficient than ASHPs. These factors strongly influence the U.S. market for GSHPs which is about 0.5% of the U.S. air-conditioning market. ASHPs will continue to dominate the market as can be seen by the production facilities and research effects of the major U.S. manufacturers. Only small companies will be able to produce GSHPs economically. (UA).

21980 (IEA-HPC-WR–2, pp. 47-63) **Benefits and utility experience with ground-source heat pumps.** O'Neil, R.A. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper reports on Niagara Mohawk Power Corporation's (NMPC's) residential experience with ground-source heat pumps (GSHPs) involving one, two, and four pipes per trench for eight horizontal and three vertical systems. Three generic heat pump types (water-to-air, triple-split water-to-air, and packaged water-to-water), both with and without domestic water heating, and advanced prototypes were involved. Computer modelling, performance monitoring, and technology transfer and commercialization

efforts were included. The resultant benefits to customers and to the utility are presented. (orig.).

21981 (IEA-HPC-WR–2, pp. 65-79) **A regional economic comparison of ground-source heat pump systems.** Statt, T.G. (Department of Energy, Washington, DC (USA)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Ground-source heat pumps (GSHPs) have the potential to dramatically reduce heating and cooling costs by utilizing the earth as a heat source instead of air, as is used with air-source heat pumps (ASHPs). In general, payback periods are shorter in colder climates, implying that GSHPs are more economic in northern regions. Using two pipes, instead of one pipe, in a trench reduces the payback period by 25-30%. Similarly, optimizing the mechanical package and incorporating domestic water heating greatly improves system economics. The most favorable GSHP system evaluated is a direct-expansion system that costs approximately 10% more than a competing ASHP system. The direct expansion system reduces annual electricity costs by 20-50%, depending on the climate. Savings increase in proportion to the heating load. The payback period varies from 1-3 years, depending on climate and electric rates. The next best was found to be an optimized two-pipe ground-coupled heat pump system with domestic water heating. This system costs approximately 30% more than the ASHP and reduces annual electric costs by 17-47%. The payback period ranges from less than 1 to 5.4 years. (orig.).

21982 (IEA-HPC-WR–2, pp. 103-110) **Vertical ground heat exchanger design.** Svec, O.J. (National Research Council of Canada, Ottawa, Ontario (Canada)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

A finite element heat transfer analysis and actual testing were used to evaluate various vertical in ground heat exchanger designs. The designs tested were finned tube, four pipe, and U-tube placed in a 30 cm diameter hole backfilled with either clay or sand. Plastic, steel, and copper pipes were used. Steady state and transient conditions were considered in the model and test. A short summary of the tests is included: The actual testing revealed that if small heat sources are placed symmetrically in a large hole and backfilled with high conductivity material (such as saturated sand) that such a heat exchanger behaves, thermally, like a pipe. A spiral heat exchanger made of 2.2 cm diameter copper tube was built to take advantage of this and was tested over a 5 month period. Conclusions are that it is possible to design a highly efficient vertical ground heat exchanger operating at temperatures below 0deg C with a length reduced by up to 1/3 of that currently used with plastic heat exchangers. (UA).

21983 (IEA-HPC-WR–2, pp. 113-118) **Research of ground-coupled systems with vertical heat exchangers.** Sanner, B. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Several attempts were made in the late 1970s and early 1980s to use vertical exchangers for ground-source heat pumps (GSHPs). Most were steel pipes driven into the ground; some used plastic pipes in drilled holes. Experiments with seasonal thermal storage were also conducted. Systematic research and development started in December 1984 with investigation of environmental effects, ground temperature recovery, and performance monitoring. Current work is centered in full-scale research station at Schwalbach, south of Wetzlar, Federal Republic of Germany. Heating performance measurements were started for a 22 kW (75 Mbh) hydronic GSHP in September 1985. The initial coaxial exchanger was replaced in July 1986 with a double U-tube, made of four high-density polyethylene pipes. The new design is less expensive, but has shown similar performance. Monitoring of 35 houses with GSHPs is used to qualify experimental results from Schwalbach. (orig.).

21984 (IEA-HPC-WR–2, pp. 119-133) **Heat exchanger design.** Cube, H.L. von (Cube Ingenieurunion, Planungsgesellschaft fuer Technischen Ausbau m.b.H., Worms (Germany, F.R.)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

The paper gives practical information for the design of a ground-source heat exchanger for heat pumps in heating-only systems. These include mathematical models, considerations and dimensions for heat exchanger spacing, pipe size and heat extraction rates. Particular attention is given to the problem of permafrost and frost-heaving effects. Practical operating experience from some previous installations in the Federal Republic of Germany are included. These systems range from a heat demand of 15 kW for a typical single-family house to that of several 100 kW for 5 larger plants (educational and government buildings). The larger plants, which are of more interest to the author, have a ground heat exchanger covering 2,500 - 15,000 m^2 of ground surface. Depending on the connection length and the heat extraction capacity, the total costs of a collector amount to 600-900 DM/kW. (UA).

21985 (IEA-HPC-WR–2, pp. 135-142) **The trench collector.** Gerbert, H. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

The results of the trench collector systems that have been installed since 1979 in Austria, Germany and Switzerland show that such systems are economic and reliable. Calculated data has been completely confirmed by the Forschungshaus Obdach. It is worth noting that no influence on vegetation could be observed, and that thermal recharge of the ground was complete before the next heating period. Similar favorable results were obtained for large installations such as that for the new elementary school building in Kisslegg. The neighboring junior high school is also heated during the transitional period from April to November. This results in year-round heating operation without a natural regeneration period. For this reason, a solar collector was installed on the roof to supply energy in the summer and regeneration in the sprin□. It can be concluded that the trench collector system with a surface area equal to one quarter of the heated floor space represents a reliable heat source that guarantees economic heating operation. Polluting emissions are decreased by 50-60% and imissions by approximately 95% compared to a conventional heating system. (orig./UA).

21986 (IEA-HPC-WR–2, pp. 149-158) **Ground heat exchanger models.** Mei, V.C. (Oak Ridge National Lab., TN (USA)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Oak Ridge National Laboratory (ORNL) has developed advanced computer models for simulating the performance of different types of ground heat exchangers. The underlying theory of these models is more rigorous than that of more simplistic models used in the past. The new models have been found to accurately predict ground-coil operations and are suitable for design use. Five different models have been completed including: Vertical deep well concentric-tube heat exchanger; Horizontal single coil with radially symmetrical soil temperature profile and soil freezing effect; Horizontal single coil with non-symmetric soil temperature around the coil; Horizontal double coil, one on top of the other in the same trench, with non-symmetrical soil temperature profile around the coil and with thermal interference effect; and Vertical, shallow-well U-tube ground coil. Four of the models were derived theoretically; one (the last) is based on an empirical correlation. All models have been well validated with either field or laboratory experimental

data. The models will provide more accurate analyses of ground coil operations than line-source theory, but they also require more computer execution time. Nevertheless, they can be used as reference models to check ground heat exchangers designed using other models. (orig.).

21987 (IEA-HPC-WR–2, pp. 159-171) **Small computer programs for GCHP design - European style.** Mogensen, P. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

The design of a ground-coupled heat pump (GCHP) system differs in many respects from that for a system using outdoor air as a heat source and sink. In contrast to such systems, the performance of GCHP systems depends on earlier load history. The design procedure therefore requires that the whole load cycle be considered. The thermal properties of the ground can vary widely from site to site and are often only approximately known. This paper describes some approaches to this problem, which are sufficiently simple to be implemented as programs on small computers. (orig.).

21988 (IEA-HPC-WR–2, pp. 173-186) **Materials, design, and installation techniques.** Hughes, P.J. (Flemming (W.S.) and Associates, Inc., Fayetteville, NY (USA)); Fleming, W.S.; Hackner, R.J. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper focuses on appropriate materials, design, and installation techniques for central New York, the primary emphasis of the author's extensive experience to date. Many of the results may be applicable in other regions where heating operation determines the required ground heat exchanger size. (orig.).

21989 (IEA-HPC-WR–2, pp. 187-199) **Analysis and field evaluation of an advanced ground-coupled heat pump system.** Baxter, V.D. (Oak Ridge National Lab., TN (USA)); Catan, M.A.; Hughes, P.J.; Hughes, H.M.; O'Neil, R.A. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. DOE Contract AC05-84OR21400. (CONF-8610224–: Workshop on ground-source heat pumps, Albany, NY (USA), 27 Oct - 1 nov 1986). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper addresses the performance of a ground-coupled heat pump (GCHP) system with a water-source heat pump (WSHP) package designed expressly for such systems for a northern climate. The research objective was to minimize the life-cycle cost (LCC) of a GCHP system by optimizing the design of both the heat pump package and the ground heat exchanger in concert. The LCC of a GCHP system with a horizontal ground heat exchanger was minimized over a seven-year economic life for an 1800 ft^2 (167 m^2) house in Pittsburgh, PA, USA. Simple payback for the optimized system, relative to conventional air-source heat pumps (ASHPs), was less than three years. The resulting WSHP design is calculated to cost approximately 20% more than its conventional counterpart, but offers a 20% higher heating coefficient of performance (COP) and a 23% higher cooling COP. The major conclusion of this study is that by improving the WSHP package efficiency, the ground heat exchanger size can be reduced by at least 30% without sacrificing performance; this can yield significant improvement in the cost competitiveness of GCHP systems. (orig.).

21990 (IEA-HPC-WR–2, pp. 201-204) **Computer models for and analysis of thermal processes in the ground.** Claesson, J. (Lund Univ. (Sweden)). IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Studies over the last ten years have resulted in theoretically-derived computer models that have been validatd by field and laboratory data. Horizontal and vertical configurations, soil freezing, and interacting heat exchangers are all addressed. Work to adapt the sizing and other models developed to run on microcomputers is underway. Ground heat pump systems use the ground for heat storage or as a heat source (or sink). The thermal processes in the ground are governed by heat conduction coupled to convective heat transfer in exchangers (e.g. wells and pipes), groundwater, and so forth. The Lund Group for Ground Heat Systems has studied these thermal processes during the last 10 years and sophisticated computer models have been developed. This paper provides a brief survey of the published studies of heat extraction from the ground; groundwater systems are not discussed. A short presentation of current work is included. (orig./UA).

21991 (IEA-HPC-WR–2, pp. 205-208) **Heat pumps for ground-coupled applications.** Hughes, H.M. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper gives a brief description of typical ground-coupled heat pump construction in North America. In general, this is the unitary type, and almost always includes cooling in addition to heating. An electric resistance heat source supplementing the heat pump during an extremely cold weather enables more practical equipment sizing, and also provides a reliable emergency heat source in the event of a system failure. Also included is a description of developments to improve the total system design on a life cycle basis by merging 3 separate computer models. (UA).

21992 (IEA-HPC-WR–2, pp. 209-217) **Ground-coupled heat pumps.** Hess, K. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This article gives some typical heat exchanger data to help size vertical heat exchangers to exploit geothermal energy, particularly in Switzerland. Temperatures of the heat transfer fluid and the ground over a period of 1 year, and the radial temperature profile around the heat exchanger, are presented graphically. Pictures of an installation process and parts of the heat pump system are included. The heat exchangers are sized to avoid ground freezing. (UA).

21993 (IEA-HPC-WR–2, pp. 219-230) **Research and development needs for ground-source heat pump systems.** Calm, J.M. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

An attempt to identify and prioritize research and development (R and D) needs for ground-source heat pumps (GSHPs) resulted in recommendations to advance the technologies and improve their acceptance. The identified requirements are based on inputs from authorities in the field obtained during an international workshop. More than 75 topics and a comparable number of elaborations were suggested. The recommendations stress simpler but more reliable design methods, cost reductions, and increased attention to information transfer and training. Rankings are presented by participant groups distinguished both by profession and between individuals from Europe and North America. The results are condensed into 18 areas of recommended research that should be helpful to those sponsoring, managing, and performing R and D of heating and cooling systems. (orig.).

21994 (LBL–24872) **Photoelectric control of daylight-following lighting systems (Daylight-sensing photocell placement): Final report.** Verderber, R.R.; Rubinstein, F.M.; Ward, G. Lawrence Berkeley Lab., CA (USA). Feb 1989. 101p.

Sponsored by U.S. DOE Conservation & Renewable Energy; Electric Power Research Institute. DOE Contract AC03-76SF00098. Order Number DE90007776. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The ability of daylight-following lighting systems to provide a minimum specified light level at the task surface is influenced by (1) the control algorithm used, (2) the spatial response of the ceiling-mounted control photosensor, and (3) the location of the photosensor relative to task and window. Best performance was obtained with a closed-loop proportional control system controlled by a photosensor, with a large field of view but shielded from direct light from the window. A minimum specified illuminance level could be maintained at specific points on the task surface regardless of daylight condition or room geometry provided that the system gain was properly calibrated to account for the local luminous environment. Open-loop proportional control also performed adequately but offered less precise control than closed-loop systems due to the necessity of using a photosensor that was not shielded from direct window light. Integral-reset systems that were tested performed poorly, but performance could be improved slightly by completely shielding the photocell from direct window light. 8 refs., 45 figs., 4 tabs.

21995 (LBL–25429) **Performance of electronic ballast and controls with 34 and 40 watt F40 fluorescent lamps.** Verderber, R.R.; Morse, O.; Rubinstein, F.M. Lawrence Berkeley Lab., CA (USA). Jun 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8810312–2: AUTOTESTCON '88: IEEE international automatic testing conference, Minneapolis, MN (USA), 4-6 Oct 1988). Order Number DE90007772. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The electric and photometric characteristics have been compared for 40 watt (40W) and 34 watt (34W), F40 T-12 fluorescent lamps by operating them with electronic ballasts, static controls and dynamic controls of different designs. The energy savings krypton filled 34W lamp system is, at best, slightly more efficacious than the standard 40W argon filled lamp system by virtue of the use of lite white phosphor. The 34W system has limitations that include higher starting voltages, reduced temperature range of operation, smaller dimming range and poorer color rendering than the standard cool white 40W lamp system. 9 refs., 7 figs., 9 tabs.

21996 (LBL–26262) **Dynamic extension of the Simulation Problem Analysis Kernel (SPANK).** Sowell, E.F. (California State Univ., Fullerton, CA (USA). Dept. of Computer Science); Buhl, W.F. Lawrence Berkeley Lab., CA (USA). 15 Jul 1988. 17p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-8809455–1: USER-1 conference, Ostend (Belgium), 6-8 Sep 1988). Order Number DE90008046. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Simulation Problem Analysis Kernel (SPANK) is an object-oriented simulation environment for general simulation purposes. Among its unique features is use of the directed graph as the primary data structure, rather than the matrix. This allows straightforward use of graph algorithms for matching variables and equations, and reducing the problem graph for efficient numerical solution. The original prototype implementation demonstrated the principles for systems of algebraic equations, allowing simulation of steady-state, nonlinear systems (Sowell 1986). This paper describes how the same principles can be extended to include dynamic objects, allowing simulation of general dynamic systems. The theory is developed and an implementation is described. An example is taken from the field of building energy system simulation. 2 refs., 9 figs.

21997 (LBL–27032) **Technology assessment: Energy-efficient commercial lighting.** Piette, M.A.; Krause, F.; Verderber, R. Lawrence Berkeley Lab., CA (USA). Mar 1989. 90p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008048. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report, one of a series of end-use energy technology assessment reports, investigates the current and potential use of lighting technologies for commercial buildings. The aim of these investigations is to synthesize current information from both published and unpublished sources so that utilities, state regulatory commissions, and others can better identify, evaluate, and select demand-side resources to meet their needs. The material covered in these reports is not limited to "success stories" but also includes failures, barriers, uncertainties, and information gaps. In addition, we attempt to identify and, if possible, reconcile variations or discrepancies among data sources. The technology assessment reports are designed to be easily updated in the future as the technologies develop and better data become available. 5 figs., 22 tabs.

21998 (LBL–27277) **More efficient household electricity use: An international perspective.** Schipper, L.; Hawk, D.V. Lawrence Berkeley Lab., CA (USA). Dec 1989. 46p. DOE Contract AC03-76SF00098. Order Number DE90007755. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The energy efficiency of electric appliances has increased markedly in OECD countries, according to data provided by utilities, appliance associations, appliance manufacturers, and independent analyses of each country we reviewed (US, Sweden, Norway, Holland, Japan, Germany, UK). These improvements have, in part, offset increases in electricity demand due to increasing saturation of appliances. However, we see evidence that the efficiency of new devices has hit a temporary plateau: Appliances sold in 1988, while far more efficient than similar ones sold in the early 1970s, may not be significantly more efficient than those sold in 1987. The reason for this plateau, according to manufacturers we interviewed, is that the simple energy-saving features have been incorporated; more sophisticated efficiency improvements are economically justified by five to ten year paybacks, but unattractive to consumers in most countries who appear to demand paybacks of less than three years. Manufacturers see features other than efficiency — such as number of storage compartments and automatic ice-makers — as more likely to boost sales, market share, or profits. If this "efficiency plateau" proves lasting, then electricity use for appliance could begin to grow again as larger and more fancy models appear in households. 38 refs., 10 figs., 1 tab.

21999 (LBL–27315) **The energy conservation potential associated with thermally efficient fluorescent fixtures.** Sminovitch, M.; Rubinstein, F.; Verderber, R.; Crawford, D. Lawrence Berkeley Lab., CA (USA). Jun 1989. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-891028–1: 12. world energy engineering congress, Atlanta, GA (USA), 25-28 Oct 1989). Order Number DE90007763. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes the energy conservation potential associated with thermally efficient fluorescent fixtures. Various approaches to improving fixture efficiency through the optimization of lamp wall temperature are discussed. The energy saving potential using thermally efficient fixtures is estimated for a sample lighting layout for an office space. This analysis indicates that both power density and the number of fixtures can be reduced with thermally efficient fixtures. Conservation potential on a national level is also estimated, using market profiles obtained from fixture manufacturers in conjunction with measured fixture performance data. 10 refs., 14 figs.

22000 (LBL–27995) **Mathematical modelling of infiltration and ventilation.** Feustel, H.E. Lawrence Berkeley Lab., CA (USA). Nov 1989. 22p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008071. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is particularly important to be aware of the air flow pattern in a building when determining indoor air quality problems or calculating space conditioning loads for energy consumption. Correct sizing of space conditioning equipment is also dependent upon accurate air flow information. A number of infiltration models have been developed to calculate infiltration-related energy losses and the resulting air flow distribution in both, single-zone and multizone buildings. International infiltration research has been conducted since the early twenties — infiltration modeling, however, is a relatively new task. Most of the modeling effort has taken place during the last 15 years, during part of which time the Air Infiltration and Ventilation

Centre has been in operation This paper gives an overview of the development of infiltration models.

22001 (LBL–27996) **The COMIS [Conjunction Of Multizone Infiltration Specialists] infiltration model.** Feustel, H.E. (Lawrence Berkeley Lab., CA (USA)); Grosso, M.; Phaff, J.C.; Allard, F.; Herrlin, M.; Utsumi, Yasuo. Lawrence Berkeley Lab., CA (USA). Nov 1989. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008064. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The COMIS workshop (Conjunction Of Multizone Infiltration Specialists), using a multi-national team, is planning to develop a reliable, smooth running multizone infiltration model on a modular base. This model not only takes crack flow into account but also covers flow through large openings, single-sided ventilation, cross ventilation and HVAC-systems. The model contains a large number of modules which are peripheral to a steering program. COMIS can also be used as a basis for future expansion in order to increase the ability to simulate buildings. Small task groups were formed to work on particular problems in developing the modules. Each COMIS team member works on several task groups. 16 refs.

22002 (LBL–28321) **Model estimates of the contributions of environmental tobacco smoke to volatile organic compound exposures in office buildings.** Daisey, J.M.; Gadgil, A.; Hodgson, A.T. Lawrence Berkeley Lab., CA (USA). Jan 1990. 14p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8911166–2: Total exposure assessment methodology Environmental Protection Agency symposium, Las Vegas, NV (USA), 27-30 Nov 1989). Order Number DE90007770. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Volatile organic compounds (VOC) in office buildings originate from multiple sources, such as outdoor air, building materials, occupants, office supplies, and office equipment. Many of the VOC found in office buildings are also present in environmental tobacco smoke (ETS), e.g., benzene, toluene, formaldehyde. Measurements made to date in Office buildings have been interpreted by some to imply that the contributions to ETS to VOC exposures in office buildings are small. Four different ventilation-infiltration scenarios were modeled for a typical office building. The purpose of this investigation was to provide first-order estimate of the range of contributions of ETS to VOC contributions in office buildings under various ventilation conditions through the use of a mass-balance model and to evaluate the significance of such contributions relative to the VOC concentration measured in office buildings. 25 refs., 1 fig., 4 tabs.

22003 (MCC–CE02780, pp. 13-18) **Modelling of thermal systems from technical sketches to equations.** Lebrun, J. (Univ. of Liege, Liege (Belgium)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

There is a need for standardization in the way modellers and users of simulation software need to standardize ways to state the physical bases of their models. This paper presents a proposal for standardization based on classical thermodynamics. very classical way of describing thermodynamical systems. The basis is the reference volume which may be crossed by mass and energy flows and which may also have some (mass and/or energy) capacity. R-C networks are nothing more than degenerate or simplified sets of reference volumes. All the buildings and (HVAC) heating, ventilation and air cooling subsystems may be subdivided into sets of interconnected volumes. Technical systems may often be subdivided into volumes of reference, on which mass and energy balances have to be established. This paper highlights the derivation of thermal equations for mass and energy balance, state variables, convection, and dynamic heat exchange. 19 figs.

22004 (MCC–CE02780, pp. 187-192) **Model-based computer aided modelling: An approach for building energy simulation improvement.** Dubois, A.-M. (Centre Scientifique et Technique du Batiment, Valbonne, Cedex (France)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Many criticisms have been made about existing software for building energy analysis and simulation; this paper uses the model-based approach. The credibility of simulation results is pointed out. Although first tentative works have shown the interest of the approach, the proforma filling appears as a difficult task, leading to the specification of a new tool. The interest of making prototype has been raised again. The use of more knowledge about the models may increase the capabilities of the energy analysis systems. Through the use of advanced computer tools such as oriented object knowledge representation and heterogeneous data base management systems, the opportunity is given to design new generation modelling and simulation environment. 10 refs., 4 figs.

22005 (MCC–CE02780, pp. 181-186) **Building energy simulations for design, evaluation, commissioning, control and diagnostics.** Subbarao, K. (Solar Energy Research Inst., Golden, CO (USA)); Burch, J.D.; Hancock, C.E. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

The most common use of building energy simulations is in the design of buildings, especially non-residential. It is a common perception that the simulations ought to be useful for many other applications, such as commissioning, control and diagnostics. A distinguishing feature of the latter applications is that they require linking with monitored data, and this link must be addressed before the applications can be realized. In linking with data, only a small number of parameters can be reasonably estimated from typical building performance data whereas a realistically complex model of the building has a large number of parameters. This dilemma is resolved and the mathematical sophistication of microdynamic simulations (i.e., simulations such as DOE-2 which simulate each component) is brought to bear on the problem by a technique called PSTAR (Primary and Secondary Terms Analysis and Renormalization). This allows a simulation on the as-built building performance is explained. Applications to commissioning, control and diagnostics are outlined as well as further developments necessary for field applications. 7 refs., 4 figs.

22006 (MCC–CE02780, pp. 265-270) **The COMIS [Conjunction of Multizone Infiltration Specialists] infiltration model.** Fuestel, H.E. (Lawrence Berkeley Lab., Berkeley, CA (USA)); Grosso, M.; Phaff, J.C.; Allard, F.; Herrlin, M.; Utsumi, Y.; Dorer, V.B.; Liu, M. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

The task is for COMIS to develop a reliable and well running multizone infiltration model on a modular base. This model does not only take crack flow into account, but also covers flow through, large openings, single sided ventilation, cross ventilation and HVAC-systems. The model contains a large number of modules, which are peripheral to a steering program. COMIS can be used as a basis for future expansions in order to increase the capabilities of simulating buildings or their type of construction, in the field of ventilation, heat flow and spread of pollutants. To develop the different modules, small task groups were formed to work on particular problems. Each COMIS team member works on several task groups and might be responsible for one or more of them. Due to the internationality of the group, several national and international research programmes are co-ordinated with the COMIS workshop as well as the outline of the COMIS model. 5 refs.

22007 (MCC–CE02780, pp. 232-239) **A summary of building energy analysis and design tool evaluation results from IEA Task 8.** Holtz, M.J. (Architectual Energy Corp., Boulder, CO (USA)); Wortman, D.N. MCC Systems Canada, Inc., Toronto, ON (Canada).

1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper summarizes the results of numerous building energy analysis and design tool evaluation exercises that included: empirical validation of detailed simulations using passive solar test room data from Canada, Switzerland and the U.S; code to code comparison of detailed simulations for several passive solar system types in Copenhagen and Denver; comparison of simplified design tool performance prediction to detailed simulation prediction for realistic passive solar buildings (direct gain, storage wall and sunspace), light and heavy weight construction, in three climates (Denver, Geneva and Copenhagen); comparison of simplified design tool performance prediction to detailed simulation performance prediction for simplified (shoebox) passive solar test cases in three climates (Denver, Geneva and Copenhagen); evaluation of the capability and user-friendliness of residential energy design tools; and development of 28 benchmark test cases for simplified design tool evaluation, based on the results of six detailed simulations. 6 refs., 10 figs., 3 tabs.

22008 (MCC-CE02780, pp. 213-216) **How good are single zone - monthly based - correlation methods for building energy and comfort performance assessment.** Perre, R. Van de (Free Univ. of Brussels, Brussel (Belgium)); Massart, A. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Several single zone, monthly based, correlation methods have been developed at a national level, over the past few years. The validity of a single zone, monthly based, correlation approach is analysed for residential building types in different European climate zones. A parametric analysis has been performed on different construction and building types. Simulation results are compared with calculations which follow the draft EUROCODE methodology, the IEA annex XII methodology, and the French Method 5000 methodology. A sensitivity study was undertaken with regard to environmental parameters, building parameters and heat transfer mechanism, in the scope of energy and comfort performance assessment. This paper also contains several indications for future design tool development. 12 refs., 2 tabs.

22009 (MCC-CE02780, pp. 299-304) **A primer on the use of influence coefficients in building simulation.** Spitler, J.D. (Univ. of Illinoise, Urbana, IL (USA)); Fisher, D.E.; Zietlow, D.C. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

In order to create a simulation model of a building, it is usually necessary to make a number of assumptions and/or approximations about the building being stimulated. Many physical quantities cannot be known precisely when the building is being simulated. For example, the real amount of infiltration is almost never known because it is impossible to predict accurately and difficult to measure. Other examples include quantity and type of internal mass, thermophysical properties of the building materials, ground temperatures, and equipment efficiencies. In order to gage the accuracy of a simulation, it is necessary to estimate the relevant significant of the assuptions made. By determining which assumptions have disnificant impact on the building energy consumption, it is possible to determine where effort should be made to refine the simulaiton. In addition, potential errors can be estimated. One method of determining the significance of the assumptions made when simulating a building involves the use of influence coefficients. An influence coefficient is the partial derivative of a simulation result with respect to a parameter. This paper describes the use of influence coefficients to estimate the significance of assumptions made in the building simulation process. 6 refs., 2 figs., 3 tabs.

22010 (MCC-CE02780, pp. 291-296) **A new model to compute air distribution.** Pelletret, R. (Centre Scientifique et Technique du Batiment, Valbonne, Cedex (France)); Khodr, H. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

In thermal simulation codes for buildings, aeraulic transfers are computed either with very simplified models (fixed air distribution) or with sophisticated models (based on the computation of the pressure fields). The simplified models are not accurate enough and the sophisticated models are too complicated for situations requiring thermal computations only. An intermediate model has been developed. This new model is based on the computation of the temperature fields and on the knowledge of an average air distribution due to air leakage and specific ventilation. So, as this model needs no computation of the pressure fields, it is well adapted to thermal stimulation codes. The new model has been validated on a real scale experiment. Details are provided on the validation aspects. The final aim of this research is to evaluate the influence of taking into account the internal partition of the buildings on the computaion of thermal performances either of envelops components or of heating systems components. 10 refs.

22011 (MCC-CE02780, pp. 285-290) **The cost of increased ventilation air.** McCutcheon, E.S. (RTM Engineering Ltd., Calgary, AB (Canada)); Vardabasso, M. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

The present American Society of Heating, Refrigeration and Air Conditioning Engineers (AHRAE) standard 62-1981 "Ventilation for Acceptable Indoor Air Quality" is being revised. The recommended ventilation rate will be increased four-fold from 2.5 l/s/person to 10.0 l/s/person. The immediate response to this proposal is that the energy consumption and costs will parallel this increase and rise dramatically. This paper provides a better understanding of the actual effect of the changes to the ASHRAE standard. The building simulation data and the design parameters used to analyze the effects of the proposed increase in the minimum outside air ventilation rate. These include the building construction, building air systems, weather data, building simulation program background and calculation methods. The result obtained from performing an analysis for each building system by increasing the minimum outside air ventilation rate 4-fold from 2.5 l/s/person to 10l/s/person are explained. The interpretation pays particular attention to the effect economizers have on the energy consumption of building air systems.

22012 (MCC-CE02780, pp. 271-278) **Predictions of thermal comfort and pollutant distribution for a thermostatically-controlled, air-conditioned, partitioned room: Numerical results and enhanced graphical presentation.** White, M. (Pacific Northwest Lab., Richland, WA (USA)); Eyler, L.L. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615--: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE-02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

An index of local thermal comfort and pollutant distributions have been computed with the TEMPEST computer code, in a transient simulation of an air-conditioned enclosure with an incomplete partition. This complex three-dimensional air conditioning problem included forced ventilation through inlet vents, an infiltration source, a pollutant source, and a thermostatically controlled air conditioning system. Five forced ventilation schemes that varied in vent areas and face velocities were simulated. Thermal comfort was modeled as a three-dimensional scalar field dependent on the fluid velocity and temperature fields; where humidity, activity levels, and clothing were considered constants. Pollutant transport was incorporated through an additional constituent diffusion equation. Six distinct graphics techniques for the visualization of the three-dimensional data fields of air velocity, temperature, and comfort index were

tested. This paper reports the results from a finite-difference approach to the solution of the Navier-Stokes and constituent diffusion equations, and its application to the simultion of an air-conditioned building with a pollutant source. 4 refs., 7 figs., 1 tab.

22013 (MCC–CE02780, pp. 240-247) **Advances in building simulation.** Seth, D. (Public Works Canada, Ottawa, ON (Canada)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

In recent years, researchers, designers and contractors have begun to investigate the use of new technologies in building construction and operation. The search for more efficient designs has led to complex and difficult-to-analyse components, systems, and whole building structures. Existing building energy simulation programs were initially conceived in an area when design questions were simpler than they are today. As a result, there are fundamental limitations in the analysis capabilities of these programs. In five to ten years, the use of computer-aided design (CAD) systems for buildings will be commonplace; expert systems will be developed to improve decision making in architectural and engineering design and operational problems and energy management systems will increasingly be used for building control, monitoring and diagnostics. the advanced building simulation programs will greatly facilitate the integration of performance simulation with design simulation, thus ensuing that energy efficiency and comfort evaluation issues receive proper emphasis in building design and control. Furthermore the integrated building systems will facilitate the creation of modularized, user-friendly and easy to operate programs for analysis of building components and their interaction. 15 refs., 4 figs., 2 tabs.

22014 (MCC–CE02780, pp. 217-222) **Evaluation procedures for building thermal simulation programs.** Bloomfield, D.P. (Systems Performance Prediction, Watford, Herts (UK)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper describes the techniques for validating dynamic thermal models devised by collaborating institutions in the United Kingdom. Following a review of past work on model validation, the United States Solar Energy Research Institute (SERI) methodology was used as a starting point. Emphasis was placed on thorough theoretical reviews of basic physical processes treated by programs and on the actual techniques adopted in some widely used programs. These were used to test the validation methodology. The main processes reviewed were internal longwave radiation, external convection conduction and shortwave solar radiation. A new set of analytical tests for conduction was devised. These provide a sensitive tool for detecting errors and for examining the consequences of different numerical solution methods. A detailed review of experimental data sets was conducted in order to assess their suitability for validating thermal simulation programs. Attempts were also made to devise improved statistical techniques for comparing measured and predicted quantities. This paper highlights the main conclusions and describes relevant new activities. 13 refs., 3 figs.

22015 (MCC–CE02780, pp. 259-264) **Indoor air quality simulation: IAQPC [Indoor air quality simulator for personal computer].** Owen, M.K.; Lawless, P.A.; Ensor, D.S.; Sparks, L.E. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

The Indoor Air Quality Simulation for personal computers (JAQPC) has been developed in response to the growing need for quick, accurate predictions of indoor air contamination levels. Many building use energy programs are currently in use, but heating, ventilating, and air conditioning (HVAC) system designers needs a way to determine if a planned system will ensure the health of building occupants. This program models up to six pollutants concurrently for buildings of up to 20 rooms. Most single-story buildings can be adapted to one of the sic available floor plans. Buildings with more than one story may be modeled if the stack effects can be ignored. IAQPC allows inclusion of sources, sinks, and air cleaners in the rooms and in the HVAC system. Up to eight sources, four sinks, and two air cleaners can be described, then selected for the individual rooms. In addition to the room air cleaners, up to two types may be selected for the HVAC system. Outdoor air concentrations are specified and the method for determining intial indoor concentrations is chosen. Air flows are calculated by the program based on the cross-sectional interconnections between the rooms, the HVAC system, and the outdoor air. The total flow through the system is specified, then an iterative approach determines the flows. The improved algorithms used to determine the concentrations have been tested against experimental data and found to yield accurate predictions in a fraction of the time necessary for other current models. This paper describes the model's inputs, calculations, and outputs. 4 refs., 4 figs.

22016 (MCC–CE02780, pp. 248-253) **Discussion paper on IEA [International Energy Agency] Annex 21 Calculation of Energy and Environmental Performance of Buildings.** Seth, D. (Public Works Canada, Ottawa, ON (Canada)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

At a meeting of the International Energy Agency (IEA) Excutive Committeee held in Ottawa, Canada, in June 1988, it was decided to conduct a defintion/feasibility study into the formation of a new Annex entitled "Calculation of Energy and Environmental Performance of Buildings", with participation from international experts. The need for such a study was identified to avoid any start-up uncertainty about Annex. This study is being carried out by a Task Group with participation from twelve countries led by the U.K. The study phase is to be completed by May/June 1989. Following a workshop on thermal modelling, U.K. prepared a draft proposal on the objectives and sub-tasks of the proposed Annex. The first meeting of the Task Group was held in Abingdon, U.K. 7-9 December 1988. At this meeting representatives of twelve countries discussed and exchange R&D related activities already completed and/or underway in their own country. At the conclusion of the three day meeting, a number of tasks were assigned to member countries for further revision and development. It was also decided to prepare a discussion paper on the topic because IEA representatives expressed a common desire to further assess the appropriateness of sub-task A,B and C to the proposed Annex. Canada volunteered to prepare the discussion paper. A list of ten recommendations is included.

22017 (MCC–CE02780, pp. 225-231) **Evaluation of the energy use of buildings, systems and plants.** Stephan, W. (Univ. of Stuttgart, Stuttgart (Germany, F.R.)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper is based on work done within the International Energy Agency ANNEX 10 system simulator group in which eight research institutes selected simulation models for heating and air conditioning components. The computer codes allow a comprehensive calculation of the energy comsumption and energy flow within buildings, systems and plants. The evaluation of these values can also be done using more general methods such as cost, penalty functions, or knowledge-based evaluation methods. This paper deals mainly with a proposal on standardizaton method to present and evaluate energy values calculated for buildings with conditioning systems and plants. It is suggested that a presentation be made in three parts. The first part defines important energy flows within the building or system including the building energy gain, the building load, heat loss in the air handling and heating system and the heat distribution system, energy production within the building, and energy supply. The thermodynamic evaluation may analyze energy in terms of efficiency, (useful energy produced divided by

energy consumed) or effectiveness (energy use of the ideal process divided by energy use of the real process). The building performance should finally be evaluated in terms of cost/benefit or in terms of penalty functions. 7 refs., 5 figs., 1 tab.

22018 (MCC–CE02780, pp. 375-380) **Accurate boiler models for large scale simulation.** Laret, L. (Centre Scientifique et Technique du Batiment, Valbonne, Cedex (France)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Detailed boiler models were developed from power plant analysis. These models simulate very accurately the combustion process and the complex heat transfer inside the combustion chamber. The detailed geometry and composition of the different boiler elements are input manually. The models are overdetailed for the simulation of domestic hot water boilers. On the other hand, the simpler models available are based on limited operating curve, even sometimes a constant efficiency. A rather fair approximation of domestic hot water boilers is given by the Dietrich law which considers a linear operating curve between the useful heat and the time on ratio in cycling conditions. This last model cannot treat some significant effects occurring as a result of the new strategies developed for up-to-date hot water heating systems, for instance, the accurate system sensitivity to water temperature, to air excess or burner tuning. The model proposed in this paper overcomes most of these drawbacks. 7 refs., 4 figs.

22019 (MCC–CE02780, pp. 369-374) **Commercial building HVAC [heating, ventilation, aiorcooling] technology screening tools.** Rohmund, I. (Regional Economic Research, Inc., San Diego, CA (USA)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Commercial building owners and managers face a complex array of (HVAC) heating, ventilation and air cooling technology options. Economic analysis of the options requires consideration of technology characteristics, equipment operating strategies, and utility rates. The interaction among these factors is complicated, requiring structured analysis tools that go well beyond simple spreadsheets. To provides a uniform and well-tested approach, the Electric Power Research Institute has developed COOLAID, COOLGEN and COMTECH which are PC analysis tools for commercial building technologies. The focus of both programs is to provide analysts and engineers with a method for understanding the economic impacts of alternative technologies on equipment costs and utility bills, and for conveying these impacts to decision-makers. These programs serve as a first-level screening tools, and provide the basis for more detailed evaluations with hour-by hour building simulation models. This paper discusses the features and uses of these programs. 11 figs.

22020 (MCC–CE02780, pp. 357-362) **Thermal energy storage system sizing.** Dumortier, D. (Lawrence Berkeley Lab., Berkeley, CA (USA)); Kammerud, R.; Birdsall, B.; Anderson, B.; Eto, J.; Carroll, W.L.; Winkelmann, F. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper describes results from a larger project which investigated the sizing of thermal energy storage (TES) systems used as part of the cooling system in buildings. The study was based on DOE-2 simulations: Daily intergrated cooling coil energy requirements for office and retail buildings in the Chicago, Fort Worth, and Miami climates were examined in relation to climate and operational parameters. Based on these studies, it was concluded that the peak daily integrated coil load, which determines the storage capacity, occurs during multiday periods of severe weather that do not necessarily include the most severe day or the most severe hour in a particular climate. A significant component of the peak daily intergrated coil load is due to energy accumulated during the periods when the building is not cooled, and stored in building materials and furnishing; ultimately the stored energy must be removed by the cooling system in order to satisfy comfort requirements during occupied periods. The magnitude of the of the stored energy component of the peak depends on the lengths of the uncooled period and of the severe climate period, and on a host of building design parameters relating to its thermal capacity and its interactions with the climate. 6 refs., 5 figs., 2 tabs.

22021 (MCC–CE02780, pp. 347-354) **The analysis of enthalpy control strategies and its application in hot and humid climates.** Yang, K.H. (National Sun Yat-Sen Univ. Koahsiung, Taiwan (China)); Hwang, R.L.; Ker, Y.P. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Air enthalpy contol strategy, or often known as free cooling, has been very effective in conserving building air-conditioning power consumptions, in moderate climatic areas. However, it stands for a challenge on its application in hot and humid areas, such as in Taiwan, where outdoor air enthalpies are constantly high. Three control schemes, namely, those using temperature control (economizer, or T-control), enthalpy control (H-control), and the modified temperature control (MT-control) were studied. The MT-control method was applied on a full-scale energy test house for experimental investigation. Night ventilation in scavenging residual heat gain through building envelope had successfully introduced lower indoor temperatures as expected in a typical April day. The simulation result of their annual performances was also validated that enthalpy control strategies have quite limited application potential in hot and humid areas, especially in the summer when cooling is most needed. 2 refs., 7figs., 3 tabs.

22022 (MCC–CE02780, pp. 341-346) **Condensation targeter: The integration of a thermal and moisture model.** Oreszczyn, T. (Polytechnic of Central London, London (UK)); Boyd, D.; Cooper, P. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper describes a design tool, condensation targeter, for assessing condensation risk in dwellings and the effect of remedial measures thereon. The BREDEM energy model is augmented by a moisture model to determine mean internal relative humidity(MIRH). This measure of condensation risk is calculated for two zones in a dwelling from mean internal temperature, moisture generation and ventilation rates. Primary input data relate to occupancy (fuel expenditure and moisture production) and dwelling characteristics (thermal and ventilation). MIRH results are presented as a function of space heating input for an example dwelling with remedial measures applied (insulation and extract fans). The constraints imposed by household income and the implications for condensation risk are discussed. Comparisons between model predictions and monitored results are discussed as is the sensitivity of predictions to the accuracy of imput data.

22023 (MCC–CE02780, pp. 312-316) **The use of the COMBINE program with DOE2.1C.** Hatten, M. (Brown and Caldwell Consulting Engineers, Eugene, OR (USA)). MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

COMBINE is a file utility program developed by Lawrence Berkeley Laboratories for use with the DOE2.1C building energy simulation program. COMBINE merges the data arrays that are passed from the SYSTEMS simulation subprogram to the PLANTS simulation subprogram in DOE2.1C. To date, it has not received extensive publicity but it is a program that expands the applications and power of DOE2.1C and it deserves recognition as one of the most practical building energy simulation innovations of the past

several years. This paper discusses the COMBINE program from the perspective of a user of DOE2.1C. COMBINE expands the limits of DOE2.1.C by increasing the number of spaces that can be contained in a single building energy simulation model, by allowing explicit modeling of campus and district heating and cooling systems on a building by building basis and by focusing attention on the plant simulation capabilities of the DOE series of building energy simulation programs. COMBINE creates new opportunities for the use of buildimng energy simulation in the solution of complex engineering and planning problems. Use of COMBINE represents on strategy for improving the state of simulation software with a minimum of additional effort. Future developments that would improve COMBINE include the development of COMBINE for use with the LOADS subprogram and for use with microcomputer-based versions of DOE2.1.

22024 (MCC–CE02780, pp. 305-311) **Building performance simulation: Delivering the power to the profession.** Clarke, J.A. (Univ. of Strathclyde (Scotland)); Rutherford, J.; MacRandal, D. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

At the present time several powerful simulation models exist for the assesssment of building environmental performance at the deign stage. However when used as design tools these models suffer from several limitations. Typically they fail to tackle the problematic issues surrounding data preparation in the face of uncertainty. Invariably models are functionally orientated, containing little knowledge of the application dormain. This means that they cannot direct a users' line of enquiry. These are the limitations being addressed in a project to develop an intelligent front end (IFE) for building performance simulation. The objective is the design of a machine environment which can act as an expert consultant to assist the user in the problem description phase, recognise the user's appraisal wishes, commission simulations and report back on overall performance. This paper describes the form and content of the IFE which is conceived as an intricate synthesis of user modelling human-computer interaction techniques, contextual knowledge and the interface to the various performance prediction models at its back-end. It also discusses the knowledge entities contained within, and manipulated by, the IFE. 11 refs., 2 figs.

22025 (MCC–CE02780, pp. 319-324) **Rule-based diagnostic method for HVAC fault detection.** Liu, S.T. (National Inst. of Standards and Technology, Gaithersburg, MD (USA)); Kelly, G.E. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

In a typical computer-based building energy mangement system (BEMS) for HVAC applications, pertinent variables such as pressure, temperature, fluid flow rate, valve and damper postions and the open/close status of the flow control devices, are measured for control and energy monitoring purposes. This paper describes the development of a prototype computerized diagnostic method for the detection of faulty equipment in an HVAC air handling unit (AHU) using sensor data from the BEMS as input. The method uses a computer model of the AHU to compute a set of optimum performance parameters for the AHU under normal operating conditions and compares the parameters with actual values calculated from the measured sensor data. Deviations between the two sets of parameters are an indication of either an out-of-tune system or malfunction of certain equipment. The program points out to the building operator the source of the fault and the possible cause in a timely fashion. The modeling part of the program is computation intensive and is written in the FORTRAN language. The diagnostic part is rule-based and is written in the symbolic language Prolog for its inference capability. Example case runs are presented to illustrate the proposed method. 5 refs., 3 figs., 1 tab.

22026 (MCC–CE02780, pp. 363-368) **Development of a component program library for building energy simulation. A Japanese experience.** Ishino, Hisaya (Tokyo Metropolitan Univ., Tokyo (Japan)); Shukuya, Masanori. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

This paper describes the program library for building energy stimulation and the current state of its developement, which has been made by a working group in Japan since 1985. The purpose of developing this component program library is to assist researchers and engineers in designing their own programs for their own objectives. Since the early 1970s, wuite a few building energy simulation programs have been developed. In Japan, programs called HASP and ACSS are also avaliable. Although these programs are usually suitable for stimulating a normal building, it is not often that they can automatically be used to simulate new energy saving strategies in air-conditioning systems, innovative window systems, etc. To accomplish such simulation, one usually miust modify portions of the computer program being used. These problems may be resolved by the use of the component program library for building energy simulation. 19 refs., 4figs., 1 tab.

22027 (MCC–CE02780, pp. 333-340) **Modeling heat, moisture and contaminant transport in buildings: Toward a new generation software.** Kerestecioglu, A. (Florida Solar Energy Center, Cape Canaveral, FL (USA)); Swami, M.; Fairey, P.; Gu, L.; Chandra, S. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

The advent of computers has provided a tremendous impetus to the development of computational analyses. High-speed computers have made it possible to solve ever more complex problems and, as a result to gain much better insight into complex processes. This paper describes a general purpose software, Florida Software for Engineering Calculations (FSEC 1.1), that is capable of solving various transport equations used in building science e.g., combined heat and moisture transfer, fluid flow, contaminant dispersion equations. The governing equations are solved by finite element methods. General capabilities and an overview of the software structure are provided. Results are presented for several types of combined heat and moisture transfer simulation: in buildings; in the presence of natural convection; in attics, and in a typical wall. 13 refs., 9 figs.

22028 (OH/RD–89-99-K) **Thermal performance and delivery capability of a 350-litre electric storage water heater.** Milligan, N.H. Ontario Hydro Research Div., Toronto, ON (Canada). 25 May 1989. 11p. (MICROLOG–90-00407). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A prototype 350-litre (normal) electric storage water heater was tested in accordance with selected clauses of Canadian Standards Association (CSA) Standard C191. Except for the standby energy loss, for which there is no specified maximum for this size of tank, the performance of the water heater was consistent with the CSA Standard. The standby loss was 161 W. This can be reduced in production models, by using high density fiberglass insulation and good assembly practice. This larger tank is capable of supplying hot water in residential applications requiring more than 800 litres per day. In load management applications the tank can supply 285 litres during the 16 hour on-peak period. This volume of hot water is marginal for residential applications. However, it may be useful for load management, where daily hot water consumption is less than 285 litres/day. Possible applications for the water heater are senior citizens homes, small condominiums and some types of apartments. 1 ref., 7 figs., 2 tabs.

22029 (ORNL/M–1069) **Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE [Department of Energy] Office of Buildings and Community Systems: Monthly progress report, December 1989 and January 1990.** Burn, G.; Samples,

S.D. (comps.). Oak Ridge National Lab., TN (USA). Mar 1990. 53p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90008036. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The monthly report of the Building Thermal Envelope Systems and Materials (BTESM) Program is a monthly update of both in-house ORNL projects and subcontract activities in the research areas of building materials, wall systems, foundations, roofs, building diagnostics, and research utilization and technology transfer. Presentations are not stand-alone paragraphs every month. Their principal values are the short-time lapse between accomplishment and reporting and their evolution over a period of several months.

22030 (Stralenbescherming–37) **Exhalation velocity of radon-222 of Dutch building materials and the influence of paint systems.** Dijk, W. van; Jong, P. de. Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Hague (Netherlands). Directie Stralenbescherming. Feb 1989. 54p. (In Dutch). (VROM–90029/2-89). Order Number DE90706055. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

In order to achieve a better insight concerning the source terms of radon in the Dutch dwelling in the framework of the RENA-programme an investigation has been performed into the exhalation velocity of radon-222 from building materials. From this investigation it turned out that the ventilation factor does not have any influence upon the exhalation velocity, neither an influence of alteration of air pressure could be demonstrated. The influence of air humidity upon the exhalation velocity showed a twofold picture: for gypsum a linear increase of the exhalation velocity with vapour pressure was found, while for concrete a linear decrease with vapour pressure was observed. Further it has been investigated in how far paint systems diminish the exhalation velocity of the Rn-222 from gypsum and concrete. Acryl paints, mostly used in the Dutch dwelling, did not show a decrease of the exhalation velocity and structure paints did even cause a increase of the exhalation velocity. Other types of paint based on chlorous rubber, epoxy resins and poly-urethane, in contrast, showed a clear reduction. From these, those based on poly-urethane showed the largest reduction (60-75%) at a double sided treatment of the wall. With the help of a mathematical modelling of the exhalation, estimations have been made of the exhalation velocity of Rn-222 at single sided treatment of a wall and for the exhalation velocity of Rn-220. For the fore mentioned poly-urethane-paints this yields, at an estimate, a reduction of respectivley 90-95% and 100%. 40 refs., 15 figs., 8 tabs.

22031 **Energy-efficient refrigeration and the reduction of chlorofluorocarbon use.** Turiel, I. (Lawrence Berkeley Lab., CA (USA)); Levine, M.D. *Annual Review of Energy (USA)*, 14: 173-204 (1989). DOE Contract AC03-76SF00098.

Two recent actions by the US Congress, passage of the National Appliance Energy Conservation Act (NAECA) and ratification of the Montreal Protocol on Substances that Deplete the Ozone Layer, have affected several large industries in the United States. Under NAECA, manufacturers of residential appliances must meet minimum energy-efficiency standards by specified dates. According to the Montreal Protocol, producers of chlorofluorocarbons (CFCs) must reduce the quantities of CFCs that they manufacture. CFCs have been identified as a cause of ozone depletion in the stratosphere. Since CFCs are used to improve the energy-efficiency of several appliance products, there is a potential conflict between the goals of reducing CFC use and improving energy-efficiency. In this article, the authors discuss the issues of CFC use, ozone depletions, energy-efficiency, and global climate change as they relate to residential refrigerators and freezers.

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Refer also to citation(s) 21949, 22260

22032 (DOE/EIA–0464(88)) **Household vehicles energy consumption, 1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 16 Feb 1990. 206p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007867. Available from NTIS, PC A10/MF A01 - GPO - OSTI; GPO Dep.

Several interrelated changes occurred in the residential transportation sector between 1985 and 1988. Although there was an increase in the number of miles traveled (both per household and per vehicle), the average consumption of motor vehicle fuel decreased. An increase in fuel efficiencies, in miles per gallon (MPG), was the primary reason for the decreased consumption. Vehicle fuel expenditures per household fell by 22 percent between 1985 and 1988, primarily due to a drop in the price of vehicle fuel. These findings are from the 1988 Residential Transportation Energy Consumption Survey (RTECS) conducted by the Energy Information Administration (EIA). This report is based on data from the 1988 RTECS. The 1988 RTECS provides baseline information on motor vehicle use in the residential sector. To be included in this survey, vehicles must be owned or used by the household on a regular basis for personal transportation. Company vehicles that are not owned by the household, but are kept at home and are regularly available to household members are also included. Data from the RTECS and a companion survey, the Residential Energy Consumption Survey, are available to the public in published reports and on public use tapes. 22 figs., 28 tabs

22033 (DOE/NASA/50162–3) **The experimental evaluation and application of high-temperature solid lubricants.** DellaCorte, C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jan 1990. 55p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AI01-86CE50162. (NASA-TM–102476). Order Number DE90006338. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This dissertation describes a research program meant to develop an understanding of high-tenperature solid lubrication and experimental techniques through the development of a composite lubricant coating system. The knowledge gained through this research was then applied to a specific engineering challenge, the tribology of a sliding seal for hypersonic flight vehicles. The solid lubricant coating is a chromium carbide based composite combined with silver, which acts as a low temperature lubricant, and barium fluoride/calcium fluoride eutectic, which acts as a high temperature lubricant. This composite coating provides good wear resistance and low friction for sliding contacts from room temperature to over 900°C in reducing or oxidative environments. The specific research on this coating included a composition screening using a foil gas bearing test rig and the use of thin silver films to reduce initial wear using a pin-on-disk test rig. The chemical stability of the materials used was also addressed. This research indicated that soft metallic films and materials which become soft at elevated temperatures are potentially good lubricants. The general results from the experiments with the model solid lubricant coating were then applied to a sliding seal design concept. This seal design requires that a braided ceramic fabric slide against a variety of metal counterface materials at temperatures from 25 to 850°C in an oxidative environment. A pin-on-disk tribometer was used to evaluate the tribological properties of these materials and to develop lubrication techniques. The results of this work indicate that these seal materials must be lubricated to prevent wear and reduce fiction. Thin films of silver, gold and calcium fluoride provided lubrication to the sliding materials. 22 refs., 33 figs., 12 tabs.

22034 (OT/TTE–AF-89-01) **Natural gas bus implementation at TTC's Lansdowne Garage.** Turner, J.E.; Monster, R.; Topaloglu, T. Ontario Ministry of Transportation, Downsview, ON (Canada). Transportation Technology and Energy Branch. May 1989. 61p. (MICROLOG–90-00770). Available from PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Toronto Transit Commission (TTC) recently made a commitment to purchase and operate natural-gas-powered buses. This decision necessitated a detailed investigation into the facilities and operations at the TTC's Lansdowne garage, where natural gas buses are to be first implemented. This report details the findings of the investigation, and provides the information required to define the natural gas refuelling equipment and to forecast the impact on current operations. The study was conducted in August 1988 and

concentrated on diesel bus refuelling and servicing. An analysis of this data led to the formulation of recommendations regarding natural gas refuelling facilities and bus queuing requirements. Recommendations included the use of a portable CNG compressor first, then the installation of permanent refuelling facilities; the increase of the service facility queuing area; maximum bus range with roof-mounted tanks sufficient to cover the Lansdowne route; and a need to use all available bus servicing time (6:00 pm - 5:00 am) if all trolley buses are replaced by natural gas buses, or a second servicing lane will be needed.

22035 (SAND–89-2111C) **A 10-stage reconnection demonstration launcher.** Cnare, E.C.; Widner, M.M.; Duggin, B.W. Sandia National Labs., Albuquerque, NM (USA). [1989]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004136–4: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90007653. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A small-scale, 10-stage cylindrical reconnection launcher has been designed, fabricated, and tested. Ten-gram projectiles are accelerated from rest to 317 m/s through the 0.44 m launcher assembly with a projectile kinetic energy to capacitor stored energy efficiency of 9%. Comparison of test results and computer code predictions will be presented. Results of these studies have substantiated launcher scaling at small size and have provided a useful test bed for launcher components and diagnostics. 5 refs., 6 figs.

22036 (SAND–89-2112C) **Design and performance of a multi-stage cylindrical reconnection launcher.** Kaye, R.J. (Sandia National Labs., Albuquerque, NM (USA)); Duggin, B.W.; Cnare, E.C.; Rovang, D.C.; Widner, M.M.; Brawley, E.L. Sandia National Labs., Albuquerque, NM (USA). [1989]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004136–6: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90007820. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A multi-stage, cylindrical, reconnection launcher is being tested to demonstrate electrically-contactless, induction-launch technology for solenoidal coil geometry. A 6-stage launcher system is being developed to accelerate a 5 kg mass from rest to 300 m/s with a stored energy of $\geq$200 kJ per coil stage. This launcher will provide data for model verification and the engineering basis for proceeding with larger multistage systems. This paper describes the design of the multi-stage, discrete-coil launcher. Integration of coils, projectile, power systems, and real-time fire control are discussed. Results of multi-stage firings are presented. 6 refs., 10 figs.

22037 (SAND–89-2113C) **Diagnostics and firing control for the cylindrical reconnection launcher.** Duggin, B.W. Sandia National Labs., Albuquerque, NM (USA). [1989]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004136–5: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90007677. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A real-time firing control system has been developed which controls the operation of multi-stage electromagnetic reconnection launchers. This controller, facility diagnostics, and data acquisition capabilities are described. 6 refs., 4 figs.

22038 (SAND–90-0630) **Exploratory development of the reconnection launcher, 1986–1990.** Cowan, M.; Widner, M.M.; Cnare, E.C.; Duggin, B.W.; Kaye, R.J.; Freeman, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004136–7: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90008578. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We briefly summarize the exploratory development phase for the reconnection launcher. This is an induction launcher which features a contactless, solid armature with either flat-plate or cylindrical geometry. The strategy for successful design is discussed, emphasizing the way we resolve the issues of ohmic heating and high-voltage requirements for high velocity. The indispensable role of a fast-running, mesh-matrix code is stressed. We describe three multistage launchers. One of these achieved muzzle velocity of 1 km/s with a 150-gram flat-plate projectile. The other two have launched cylindrical projectiles at 335 m/s, one with relatively heavy projectiles of 5 kg, the other with relatively light ones of 10 grams. The cylindrical projectiles can be spin-stabilized prior to launch for improved flight. We outline the potential of this technology for earth-to-orbit launch of small satellites. 19 refs., 9 figs.

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Refer also to citation(s) 21302, 21620, 21654, 21949, 21968, 21972, 22071, 22519

22039 (AI–P8072.00) **The evaluation of zeolite and sodium hydroxide chemical heat pumps: Final report.** Acres International Ltd., Toronto, ON (Canada). Feb 1988. 73p. Contract EMR 04SQ.23440-6-9199. (MICROLOG–89-06222). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study focusses on a comparison of two potentially viable chemical heat pump systems, one using liquid sodium hydroxide and the other using solid (granular) zeolite as the heat upgrading medium. An earlier study on the sodium hydroxide chemical heat pump was carried out by Acres International Ltd. As part of the present study, an independent review of that study work was carried out at the University of Toronto. This review concentrated on the absorber design methods; it confirmed the viability of the design approach. The estimated costs for building and operating the model are $40,000 and $10,000, respectively. Investigations into the properties of zeolite identified a wide range of natural and synthetic zeolites with a broad range of properties. Synthetic zeolites in the form of molecular sieves are the types most commonly identified for heat transfer work in technical publications. The applications of zeolite to the heat pumping process was evaluated, and a performance evaluation of a heat pump dryer unit was carried out through the use of a computer program, which was modified for heat pump applications. A rotating heat wheel concept was the device selected for this evaluation. The theoretical peformances of zeolite and sodium hydroxide chemical heat pumps were compared, using the bench-scale dryer system from the earlier study as the basis. For this application, the dimensions of the zeolite heat wheel and the sodium hydroxide absorption tower were found to be comparable. It is concluded that both the sodium hydroxide and zeolite heat pump concepts are technically feasible, but that more data are required to carry out a detailed comparison. 22 refs., 6 figs., 15 tabs.

22040 (ANL–89/23) **Evaluation of industrial magnetic heat pump/refrigerator concepts that utilize superconducting magnets.** Waynert, J.A. (Astronautics Technology Center, Madison, WI (USA)); DeGregoria, A.J.; Foster, F.W.; Barclay, J.A. Argonne National Lab., IL (USA); Astronautics Technology Center, Madison, WI (USA). Jun 1989. 66p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90008093. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report provides a preliminary assessment of some magnetic heat pump (MHP)/refrigeration concepts for cryogen liquefaction and other industrial applications. The study was performed by Astronautics Corporation of America for Argonne National Laboratory under the sponsorship of the US Department of Energy. Applications of interest range from the liquefaction of gases (20 K to 100 K) to cold storage refrigeration for food preservation (250 K to 320 K) to heat pumps utilizing industrial waste heat (350 K to 400 K). Initial market penetration of magnetic refrigeration devices is anticipated for low-temperature industrial applications such as the cryogen liquefaction field, and the major focus of the study is on hydrogen liquefaction (20 K) utilizing a liquid nitrogen heat sink (77 K). A brief market analysis indicated that there is a need for small

(~1 ton/day liquid hydrogen) hydrogen liquefiers with dispersed usage at appropriate sites in the country to reduce distribution costs. This provides an ideal market niche for magnetic liquefiers since conventional gas-cycle liquefiers cannot be economically scaled to small sizes. A number of design options for hydrogen liquefiers are analyzed, including thermodynamic cycles; magnetic materials; heat exchangers; process of magnetization/demagnetization; magnet configurations; source/sink connections; and regenerative, recuperative, and active magnetic regenerative concepts. 42 refs., 19 figs., 10 tabs.

22041 (BNL–52217) **Proceedings of the 1989 oil heat technology conference and workshop.** McDonald, R.J. (ed.). Brookhaven National Lab., Upton, NY (USA). Jun 1989. 233p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. (CONF-890346–: 1989 oil heat technology conference and workshop, Upton, NY (USA), 27-28 Mar 1989). Order Number DE90006329. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This report documents the proceedings of the 1989 Oil Heat Technology Conference and Workshop, conducted on March 27 and 28 at Brookhaven National Laboratory (BNL) under sponsorship by the US Department of Energy – Office of Buildings and Community Systems (DOE-OBCS). The meeting was held in cooperation with the Petroleum Marketers Association of America. The 1989 Oil Heat Technology Conference, which has been the fourth held since 1984, is a key technology transfer activity supported by the ongoing Combustion Equipment Technology Program at BNL, and is aimed toward providing a forum for the exchange of information and perspectives among international researchers, engineers, manufacturers and marketers of oil-fired space-conditioning equipment. The objectives of the Conference are to: identify and evaluate the current state-of-the-art and recommend new initiatives for satisfying consumer needs cost-effectively, reliably and safely; foster cooperative interactions among federal and industrial representatives in accordance with the common goal of national security via energy conservation. The 1989 Oil Technology Conference comprised: (a) two plenary sessions devoted to presentations and summations by public and private sector representatives from the United States, Europe and Canada; and (b) four workshop sessions which focused on mainstream issues in the field of oil-heating technology.

22042 (CC/W–57097A) **Evaluation of energy production potential of the Linden Lee Farms anaerobic digestion and electrical co-generation system: Final report.** CANVIRO Consultants, Waterloo, ON (Canada). Sep 1988. 32p. Contract EMR 5152.23216-5-7097. (MICROLOG–90-00384). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The objective of this project was to determine a detailed energy balance for the anaerobic digestion and electrical co-generation system at a swine operation in Prince Edward Island. The swine manure from this farm is fed to an anaerobic digester to produce biogas, which fuels a natural gas engine powering a generator. Waste heat from the engine is recovered and used for heating buildings and the digestive systm. An electrical generation system monitoring program was conducted to collect the data required to perform the energy balance. At a generato output of 2.5 kW or 6.3 % of the rated capacity, only 5.6% of the energy suppled as fuel went into work energy. At an output of 15kW or 37.5% of the rated capacity, 21.8% of the fuel energy went into work. At higher generator outputs a significantly greater percentage of the fuels energy is converted to work, whereas at lower outputs, most of the fuel energy goes into radiant heat. It is more fuel efficient, both for the production of electricity and recoverable heat energy, to run an engine generator at or near its maximum rated capacity, even if for only a short period of time rather than to run it continuously at lower loadings. It was estimated that at the current size of the farm (225 sows farrows-to-finish), 137 $_3$ biogas/day would be produced . At this rate of biogas production, the engine generator set could run for 9.5 hours and produce 15 kW. 4 refs., 3 figs., 7 tabs.

22043 (DOE/BP/35677–1) **Improved selection procedures for irrigation sprinklers.** Duranceau, D.A. Bonneville Power Administration, Portland, OR (USA). Feb 1990. 195p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract BI79-87BP35677. Order Number DE90008476. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A detailed study of the sealing properties of various soils in relation to the energy of water droplets from low pressure sprinkler heads indicates that energy can be saved by proper sprinkler selection. 90 refs.

22044 (ECRC/M–2344) **Plasma heated glass making.** Copsey, M.J. Electricity Council Research Centre, Capenhurst (UK). Aug 1989. 32p. Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK. Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.

The glass industry is known to be looking for more convenient and flexible alternatives to large tank furnaces. Plasma heated glass melters are, at present, the only prospective competitors to a new gas-fired melter which is now believed to be at the prototype stage of development in the USA. The general problem of matching plasma heat sources to glass making is discussed and it is concluded that the most suitable systems are those with the capacity for both transferred and non-transferred operation that do not require an electrode immersed in the melt. Plasma systems to an appropriate specification are commercially available at present. Reduction of the risk of excessive refractory erosion is seen as the major design problem for practical plasma glass melters. An outline design is proposed for an experimental, continuous melter. (author).

22045 (EPRI-CU–6562) **Supplemental photosynthetic lighting for greenhouse tomato production: Final report.** Godfriaux, B.L. (Public Service Electric and Gas Co., Newark, NJ (USA)); Wittman, W.K.; Janes, H.W.; McAvoy, R.J.; Putman, J.; Logendra, S.; Mears, D.R.; Giacommelli, G.; Giniger, M. Electric Power Research Inst., Palo Alto, CA (USA); Public Service Electric and Gas Co., Newark, NJ (USA). c Dec 1989. 79p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The influence of supplemental light on the growth and productivity of greenhouse tomatoes grown to a single cluster on movable benches is examined, and the economic feasibility of such a system is evaluated. Experiments were conducted to quantify the tomato plants' response to various levels of supplemental light in terms of growth rate and yield at various stages in their development (e.g., seedling, flowering plant, etc.). The 1984–85 experiments showed that supplemental photosynthetic lighting nearly doubled tomato yields, from 0.48 to 0.86 lbs/plant. Subsequent experiments in 1985–86 identified the best tomato varieties for this treatment and further increased yields to 1.3 lbs/plant. In addition, the use of supplemental lighting was found to hasten tomato crop maturity. An economic analysis was performed on the 1985–86 empirical data using the tax rates and provisions then in force. It indicated that a 10-acre greenhouse could provide an after-tax internal rate of return of 10% to 12% using only equity financing. This return could likely be increased to 15–18% with the use of combined debt/equity financing. Using supplemental lighting on 10,000 acres of greenhouse production would require an estimated 7.5 billion kWh of additional electricity per year and, at 4.7 cents/kWh, generate an estimated $350 million in additional utility revenues. 48 refs., 34 figs., 24 tabs.

22046 (EPRI-CU–6702-Vol.1) **The model electric restaurant: Volume 1, Restaurant subsystem analysis and evaluation: Final report.** Frey, D.J. (Architectural Energy Corp., Boulder, CO (USA)); Oatman, P.A.; Claar, C.N. Electric Power Research Inst., Palo Alto, CA (USA); Architectural Energy Corp., Boulder, CO (USA); Pennsylvania State Univ., University Park, PA (USA). c Dec 1989. 188p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Restaurants are the most intensive users of energy of all types of commercial buildings. As a result, they have some of the highest

energy costs. New and existing restaurants are important customers to electric utilities. Many opportunities exist to use electricity to improve restaurant energy performance. This report discusses a project in which computer simulations were used to investigate restaurant energy subsystem performance and to assess the potential for electric equipment to reduce energy consumption, reduce peak demand improve load factors, and reduce energy cost in new all-electric restaurants. The project investigated typical restaurant designs for all-electric and gas/electric facilities and compared them to high efficiency electric options in all-electric restaurants. This analysis determined which investiments in high-efficiency electric equipment are attractive for restaurant operators. Improved equipment for food preparation, heating and cooling, ventilation, sanitation, and lighting subsystem was studied in cafeteria, full menu, fast food, and pizza restaurants in Atlanta, Cleveland, Los Angeles, and Phoenix. In addition to the actual rate structures, four synthetic rate structures were used to calculate energy costs, so that the results can be applied to other locations. The results indicate that high efficiency and improved all-electric equipment have the potential for significantly reducing energy consumption, peak demand, and operating costs in almost all restaurants in all locations. The all-electric restaurants, with a combination of improved equipment, also offer the customer a competitive choice in fuels in most locations. 12 refs., 26 figs., 55 tabs.

22047 (IEA-HPC-WR–2, pp. 111-112) **Swedish borehole technology.** Nelson, A. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

This paper summarizes the status of well drilling technology for ground-source heat pump (GSHP) systems in Sweden. Innovative techniques have been applied to overcome the demanding drilling conditions. (orig.).

22048 (IEA-HPC-WR–2, pp. 143-147) **Direct expansion systems.** Borin, P.E. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

At a seminar in Stockholm in 1985, a comparison between direct-expansion and ground-coupled systems was given; the comparison was limited to heating-only systems. The direct-expansion system used two 90 m (300 ft) horizontal evaporators made of copper as shown in figure 1. The ground-coupled system used a horizontal heat exchanger made of plastic pipe. Both systems operated with comparable evaporating temperatures. But the installation costs of the direct-expansion system were approximately 20% lower, due to the shorter collector and the use of a less complicated product. (orig.).

22049 (OME–90-00725) **Assessment of cogeneration opportunities in selected Ontario industrial plants.** Ontario Ministry of Energy, Toronto, ON (Canada). Feb 1989. 130p. (MICROLOG–90-00725). Available from PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This report evaluates the technical and financial viability of installing privately owned cogeneration systems in a cross-section of industrial plants in Ontario. The report characterizes financially feasible cogeneration ssystems applicable to industry, and identifies actions which could be taken by the Ministry of Energy to remove impediments to the development of private sector cogeneration projects. The analysis of cogeneration opportunities was based on audits of Ontario industrial plants, technical and financial analysis of multiple cogeneration scenarios for each plant, and review of the results with the plant personnel. Findings included a good interest at the plant level, many technically feasible cogeneration possibilities and some financially feasible projects. A number of other projects were identified which would require some form of increased financial benefits to be financially feasible at present. Some companies have thermal load requirements that are conducive to cogeneration systems, but they have production capital investment requirements which take precedence over non-essential investments such as cogeneration. Plant operators were also not convinced that Ontario Hydro and the local Public Utility COmmissions want to receive independently generated power and that the rates offered are equitable.

22050 (ORNL/TM–11331) **A menu-driven program for determining properties of aqueous lithium bromide solutions.** Patterson, M.R.; Crosswhite, R.N.; Perez-Blanco, H. Oak Ridge National Lab., TN (USA). Jan 1990. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90008089. Available from NTIS, PC A03/MF A01; OSTI; Order Software Packages from National Energy Software Center, Argonne National Laboratory, 9800 South Cass Avenue, Argonne, IL 60439. Order documentation without complete package from NTIS.; GPO Dep.

This report contains a description of the computer program LIMENU for calculating the thermodynamic and transport properties of aqueous solutions of lithium bromide. A user's guide is included, together with a description of how the program produces displays and plots on the screen. The routines that calculate the properties are also described briefly. It is hoped that a program of this nature, with plotting capabilities and up-to-date information, will be useful to engineers and to researchers in the area of absorption. 4 refs., 3 figs.

22051 (PB–90-130493/XAB) **Incineration of creosote and pentachlorophenol wood-preserving waste-water-treatment sludges. Report for October 1986-September 1989.** Hall, F.D. PEI Associates, Inc., Cincinnati, OH (USA). Nov 1989. 132p. Available from NTIS, PC A07/MF A01.

This report describes the treatment of creosote and pentachlorophenol wood-preserving waste-water-treatment sludges by rotary-kiln incineration (RCRA Code K001).

22052 (PB–90-132812/XAB) **Partitioning of metals in rotary-kiln incineration.** Carroll, G.J.; Thurnau, R.C.; Mournighan, R.E.; Waterland, L.R.; Lee, J.W. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. c Sep 1989. 12p. (EPA–600/D-89/208). Available from NTIS, PC A03/MF A01.

This research project investigated the fate of trace metals in rotary-kiln incineration with venturi- and packed tower-scrubber particulate- and acid gascontrol. A test plan was developed, using a factorial experimental design, to study the partitioning of metals among kiln ash, scrubber water, flue gas particulate, and flue-gas vapor. Synthetic waste formulations included the hazardous trace elements arsenic, lead, cadmium, chromium, and barium, as well as the non-hazardous trace elements copper, magnesium, bismuth and strontium, spiked into a clay absorbent material. The independent variables chosen for evaluation were chlorine content of the feed, kiln temperature, and afterburner temperature. Cadmium, lead, and bismuth appeared volatile over the range of kiln temperatures tested, while the other six metals displayed refractory properties. Of the three independent variables tested, feed chlorine content had the strongest effect on changes in metal partitioning across the tests; as chlorine content increased, metal volatilization appeared to increase, while scrubber efficiency for metals decreased.

22053 (PB–90-855834/XAB) **Industrial heating technology. August 1983-November 1989 (Citations from the COMPENDEX data base). Report for August 1983-November 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 108p. Available from NTISPC N01/MF N01.

Supersedes PB–88-854286.

This bibliography contains citations concerning the design, development, and application of industrial heating technology. Solar, oil, gas, electrical, and microwave systems in industrial applications are discussed. (This updated bibliography contains 222 citations, 61 of which are new entries to the previous edition.)

22054 (PB–90-855966/XAB) **Solid-waste incinerators. September 1970-October 1989 (Citations from the US Patent data base). Report for September 1970-October 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 123p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855571.

This bibliography contains citations of selected patents concerning the design and utilization of incinerators and incinerator components used for the destruction of municipal, industrial, and agricultural solid-waste products. Materials-handling devices and pollution-control meassures are discussed. Integrated incinerator/heating system equipment and portable units are considered. (This updated bibliography contains 290 citations, 34 of which are new entries to the previous edition.)

22055 (PB–90-856006/XAB) **Cogeneration: Economic and technical analysis. February 1987-January 1988 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for February 1987-January 1988.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 94p. Available from NTISPC N01/MF N01.

See also PB–90-856014.

This bibliography contains citations concerning economic and technical analysis of cogeneration systems. Topics include electric power generation, industrial cogeneration, electricity-supply industry, and fuel-cell cogeneration. Steam power station, gas-turbine and steam-turbine technology, district heating, refuse-derived fuels, environmental effects and regulations, bioenergy and solar-energy conversion, waste-heat and waste-product utilization, and performance analysis are presented. (This updated bibliography contains 210 citations, none of which are new entries to the previous edition.)

22056 (PB–90-856014/XAB) **Cogeneration: Economic and technical analysis. February 1988-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for February 1988-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 153p. Available from NTISPC N01/MF N01.

Supersedes PB–88-857552. See also PB–90-856006.

This bibliography contains citations concerning economic and technical analysis of cogeneration systems. Topics include electric power generation, industrial cogeneration, electricity-supply industry, and fuel-cell cogeneration. Steam power station, gas-turbine and steam-turbine technology, district heating, refuse-derived fuels, environmental effects and regulations, bioenergy and solar-energy conversion, waste-heat and -waste product utilization, and performance analysis are presented. (This updated bibliography contains 332 citations, all of which are new entries to the previous edition.)

22057 (PB–90-856261/XAB) **Metals recovery from wastes. May 1988-December 1989 (Citations from the COMPENDEX data base). Report for May 1988-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 34p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861645.

This bibliography contains citations concerning the recovery and recycling or reuse of ferrous and nonferrous metals from various industrial wastes, especially waste waters. (This updated bibliography contains 48 citations, 18 of which are new entries to the previous edition.)

22058 (PB–90-856873/XAB) **Cogeneration: Economic and technical analysis. October 1986-September 1987 (Citations from the COMPENDEX data base). Report for October 1986-September 1987.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 84p. Available from NTISPC N01/MF N01.

See also PB–90-856881.

This bibliography contains citations concerning economic and technical analyses of cogeneration systems. Topics include cogeneration power plants, design and operation of heat supply systems, waste heat and waste product utilization, and fossil-fuel cogenerated power. Fuel-cell cogeneration perspectives, gas-turbine and steam turbine technology, district heating, protective relay and control systems, and market potential are discussed. (This updated bibliography contains 182 citations, none of which are new entries to the previous edition.)

22059 (PB–90-856881/XAB) **Cogeneration: economic and technical analysis. October 1987-December 1989 (Citations from the COMPENDEX data base). Report for October 1987-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 147p. Available from NTISPC N01/MF N01.

Supersedes PB–87-868246. See also PB–90-856873.

This bibliography contains citations concerning economic and technical analysis of cogeneration systems. Topics include cogeneration power plants, design and operation of heat supply systems, waste heat and waste product utilization, and fossil-fuel cogenerated power. Fuel-cell cogeneration perspectives, gas-turbine and steam-turbine technology, district heating, protective relay and control systems, and market potential are discussed. (This updated bibliography contains 324 citations, all of which are new entries to the previous edition.)

22060 (PB–90-856907/XAB) **Hazardous materials waste disposal. June 1987-May 1989 (Citations from the NTIS data base). Report for June 1987-May 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 168p. Available from NTISPC N01/MF N01.

See also PB–90-856915.

This bibliography contains citations concerning the disposal of hazardous industrial and municipal wastes, chemical agents, and a variety of other dangerous substances. Topics include restoration operations, contamination-abatement studies, appropriate regulation and legislation, and remedial-response strategies. Considerable attention is given to waste-disposal sites at military installations and to incineration operations. Citations pertaining specifically to radioactive waste disposal are excluded. (This updated bibliography contains 310 citations, none of which are new entries to the previous edition.)

22061 (PB–90-856915/XAB) **Hazardous materials waste disposal. June 1989-January 1990 (Citations from the NTIS data base). Report for June 1989-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 45p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863518. See also PB–90-856907.

This bibliography contains citations concerning the disposal of hazardous industrial and municipal wastes, chemical agents, and a variety of other dangerous substances. Topics include restoration operations, contamination-abatement studies, appropriate regulation and legislation, and remedial-response strategies. Considerable attention is given to waste-disposal sites at military installations and to incineration operations. Citations pertaining specifically to radioactive waste disposal and state-by-state toxic release inventories are excluded. (This updated bibliography contains 59 citations, all of which are new entries to the previous edition.)

22062 (PCCIM–CE02873, pp. 16.1-16.15, Paper) **Waste heat recovery at the Lupin Mine.** Smith, C.D. Petroleum Society of CIM (Canada). 1989. (CONF-8910368–: 4. District No.5 meeting, Calgary (Canada), Oct 1989; CE–02873). In *Mining and energy challenges.* Available from PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN.

Echo Bay Mines Ltd owns and operates the Lupin gold mine, situated 400km north-east of Yellowknife, Northwest Territories. In 1988, the operation mined and processed 1,690 tonnes of ore daily and produced 202,000 oz of gold over the year. In the absence of a power grid, it has been necessary to operate an efficient power generation and heat recovery system. The primary power and heat generation equipment is described: 6 diesel engines and 2 boilers; the power house has an installed capacity of 13MW of prime power plus 1.5MW of emergency power, and the boilers are capable of producing 40M BTU/h. Waste heat is captured from engine jacket water, lubricating oil and exhaust gases and is used to heat

the plant complex, the residence complex, and, more recently, the mine ventilation air. With increased mine development, more equipment and a greater number of working headings, a larger mine air fan was installed in 1987, and the warmer rock and equipment no longer had a significant impact on the air temperature; it was, therefore, decided that a mine air heating system would be installed prior to the winter of 1989. Diesel and propane-fired systems are compared. The heat load characteristics and the effects of the mine air heating system on the existing system are discussed and the final design of the mine air heating system is presented, including the heat exchanger: although a more complex design was required when compared to a dedicated-boler of propane-fired alternative, the chosen system is relatively simple and is cost-effective. The system has completed its first winter of operation and has achieved the desired objectives. It is estimated that Lupin achieves 73% of the contained energy value of the fuel in electricity and heat, and a potential exists to achieve 79% through the use of instrumentation and equipment. 16 figs., 2 tabs.

22063 **New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988.** MRS Symposium Proceedings. Volume 140. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. 540p. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The present conference discusses topics in low-friction engineering systems requirements, atomic and molecular scale tribobehavior, ion- and laser-modified surfaces, solid lubricants, ceramic lubrication, tribotesting methods and material evaluation techniques, and wear-resistant coatings. Attention is given to the tribological requirements of advanced spacecraft, molecular contact pressure in tribology, the tribology of amorphous alloys formed with ion beams, the friction and wear of ion beam-assisted nitride coatings, sputter-deposited MoS2 solid lubricant films, and solid lubricant films for extreme environments. Also discussed are tribological applications for advanced ceramics, fluorinated diamond films, the binding of lubricating films to refractories and ceramics, fretting damage in electrical connectors, and thin diamond films for tribological applications.

22064 **Fundamentals of tribology at the atomic level.** Ferrante, J. (Sandia National Laboratories, Albuquerque, NM (USA)); Pepper, S.V. pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Tribology, the science and engineering of solid surfaces in moving contact, is a field that encompasses many disciplines: solid state physics, chemistry, materials science, and mechanical engineering. In spite of the practical importance and maturity of the field, the fundamental understanding of basic phenomena has only recently been attacked. An attempt to define some of these problems and indicate some profitable directions for future research is presented. There are three broad classifications: (1) fluid properties (compression, rheology, additives and particulates); (2) material properties of the solids (deformation, defect formation and energy loss mechanisms); and (3) interfacial properties (adhesion, friction chemical reactions, and boundary films). Research in the categories has traditionally been approached by considering macroscopic material properties. Recent activity has shown that some issues can be approached at the atomic level: the atoms in the materials can be manipulated both experimentally and theoretically, and can produce results related to macroscopic phenomena. 33 refs.

22065 **Interfacial chemical reactions between MoS2 lubricants and bearing materials.** Zabinski, J.S. (Sandia National Laboratories, Albuquerque, NM (USA)); Tatarchuk, B.J. pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

XPS and conversion-electron Moessbauer spectroscopy (CEMS) were used to examine iron that was deposited on the basal plane of MoS2 single crystals and subjected to vacuum annealing, oxidizing, and reducing environments. Iron either intercalated into the MoS2 structure or formed oriented iron sulfides, depending on the level of excess S in the MoS2 structure. CEMS data demonstrated that iron sulfide crystal structures preferentially aligned with respect to the MoS2 basal plane, and that alignment (and potentially adhesion) could be varied by appropriate high-temperature annealing procedures. 14 refs.

22066 **MoS2 interactions with 1.5 eV atomic oxygen.** Martin, J.A. (Sandia National Laboratories, Albuquerque, NM (USA)); Cross, J.B.; Pope, L.E. pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Exposures of MoS2 to 1.5-eV atomic oxygen in an anhydrous environment reveal that the degree of oxidation is essentially independent of crystallite orientation, and that the surface-adsorbed reaction products are MoO3 and MoO2. A mixture of oxides and sulfide exists over a depth of about 90 A, and this layer has a low diffusion rate for oxygen. It is concluded that a protective oxide layer forms on MoS2 on exposure to the atomic-oxygen-rich environment of LEO. 9 refs.

22067 **Synthesis and characterization of MoS2 thin films grown by pulsed laser evaporation.** Donley, M.S. (Sandia National Laboratories, Albuquerque, NM (USA)); Mcdevitt, N.T.; Murray, P.T. pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The growth and characterization of MoS2 thin films grown by pulsed laser evaporation (PLE) are investigated. TOF analysis of the ions evaporated from an MoS2 target indicates that PLE results primarily in the evaporation of atomic Mo and S species; Mo(x)S(y) clusters were also detected, but were present at a significantly lower intensity. TOF velocity analysis indicates an effective plasma temperature of 1500 K. Stoichiometric MoS2 films were grown at substrate temperatures between room temperature and 500 C. XPS data are used to develop a Wagner chemical-state plot. Analysis of the films by Raman spectroscopy and glancing-angle X-ray diffraction indicates the films to be crystalline hexagonal MoS2, with a tendency for basal-plane orientation parallel to the substrate. 15 refs.

22068 **Tribological applications for advanced ceramics.** Jahanmir, S. (Sandia National Laboratories, Albuquerque, NM (USA)). pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Tribological applications of ceramics can be divided into several categories based on the properties of the ceramics. These include: resistance to abrasion and erosion; resistance to corrosive wear; wear resistance at elevated temperatures; low density; and electrical, thermal and magnetic properties. Examples of present utilization of ceramics in each category are described and a few examples of potential future applications are given. Many scientific and technical barriers must be overcome before the full potential of ceramics in tribological applications is realized. These barriers are discussed in terms of the limited knowledge regarding tribological performance, problems with reliability, and lack of design knowledge and experience. It is clear that the wide-spread use of advanced ceramics requires further research and development. However, it must be realized that the solutions to the scientific and technical problems will be slow. 28 refs.

22069 Tribochemical lubricious oxides on silicon nitride. Fischer, T.E. (Sandia National Laboratories, Albuquerque, NM (USA)); Liang, H.; Mullins, W.M. pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The concept of lubrication by a tribochemically generated oxide layer on the surface of silicon nitride is further investigated. Previous work has shown that low friction coefficients (about 0.1) are obtained in a range of sliding velocities and loads when otherwise unlubricated silicon nitride slides in humid air at temperatures between 150 and 650 C. In order to verify the hypothesis that this behavior results from a competition between the growth of an oxide layer (with growth kinetics accelerated by friction) and its removal by wear, model experiments were performed at room temperature, where the oxide layer is grown statically, and the friction coefficient and its evolution in time are subsequently measured. In order to avoid high friction by plowing, ultraflat surfaces were first prepared by sliding in water. The experiments showed that the oxide layer produces a friction coefficient as low as 0.05 that survives about 30 N m of sliding. When sliding in water, the surface acquires a high friction coefficient (0.7) very rapidly. 13 refs.

22070 The evaluation of materials for tribological applications. Winer, W.O. (Sandia National Laboratories, Albuquerque, NM (USA)). pp. 540 of New materials approaches to tribology: Theory and applications; Proceedings of the Symposium, Boston, MA, Nov. 29-Dec. 2, 1988. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

This paper discusses the primary environmental operating variables for different triboelements, the rationale for their importance, and how they are normally included in tribomaterial evaluation. The paper distinguishes between tribomaterial evaluation for known well defined applications and the evaluation of potential tribomaterials for which the relevant application is unknown. The objective of the material scientist, in either situation, is to select and use the evaluation program involving minimum time and cost consistent with generating results leading to design decisions with confidence. The many available bench tests are discussed, along with the role and sophistication of thorough tribosystem simulation. 9 refs.

3206 Municipalities and Community Systems

Refer also to citation(s) 21948, 21949, 21980

22071 (BNL–43833) **District cooling technology characterization case study: Austin, Texas: Final report.** Coughlan, R.T.; Andrews, J.W.; Piraino, M.; Strasser, J.J. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 73p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE90008289. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report describes the work performed under Part 2 of the project entitled "District Heating and Cooling Market Potential and Penetration Study." The project's primary objective is to study the potential of conventional and innovative district heating and cooling (DHC) space conditioning systems in the United States, in particular, those areas with significant heating and cooling load requirements. Part 2 entitled "Implementation and Application of the Conceptual Approach," employs the DHC characterization methodology, previously developed in the initial phase of the project, to compare the economic feasibility of selected DHC system types in a specific community. Task 1 of Part 2 explored a "broad-brush" DHC characterization study of a high-heating load location using Milwaukee, Wisconsin, as a case area. This report addresses the completion of Task 2 of Part 2 which examines the potential of a few selected DHC systems in Austin, Texas, whose climate indicates a large demand for cooling. The subject matter described in this report focuses on the study of some district cooling technologies in Austin using the DHC characterization computer model developed at BNL. The model was employed to compare the economic viability of selected DHC system types, particularly those involving the production of chilled water and slush ice from cogenerator waste heat. Thermal storage applications were also considered. The annualized delivered energy cost was taken as the economic figure-of-merit. 6 refs., 33 figs., 5 tabs.

22072 (CCREM–TS/WM-TREO03) **Operating and emission guidelines for municipal solid waste incinerators.** Canadian Council of Resource and Environment Ministers, Downsview, ON (Canada). Jun 1989. 87p. (MICROLOG–89-06066). Available from PC Canadian Council of Resource and Environment Ministers, 4905 Dufferin St., Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An increasing interest among Canadian communities for energy production from municipal waste incineration has caused considerable concern about the emissions generated by such facilities. In response to the need for advice on municipal waste incineration, a set of guidelines is presented to define the elements of a well designed and properly operated incineration system, and the capabilities and limitations of such a system. The most up-to-date information on municipal solid waste, energy-from-waste combustion, and related emission control systems has been considered in defining the most suitable control technology and in establishing target emission values for selected parameters. Four categories of emissions were considered: trace organics (polychlorinated and polycyclic aromatic compounds), trace metals, acid gases, and conventional combustion-related emissions such as particulates, CO, and CO_2. Emission objectives are expressed in relation to dry cubic meters of flue gas at 25° C and 101.3 kilopascals (atmospheric pressure). Recommendations are included on the handling and disposal of residual ash or other residues from the incineration process, on the monitoring and surveillance procedures for the parameters considered, and on the design, operation, and management of incinerator facilities. 2 refs., 1 fig., 3 tabs.

22073 (CC/W–KI23410AO) **Development and demonstration of new process standards for upgraded biogas energy utilization of municipal digestion facilities in Canada: Interim report. Draft.** Barclay, J.A. (CANVIRO Consultants, Waterloo, ON (Canada)); Stickney, A.R. CANVIRO Consultants, Waterloo, ON (Canada). Feb 1988. 97p. Contract EMR 6ZSS.23216-6-6166. (MICROLOG–90-00385). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The biogas generated by the anaerobic digestion facilities in municipal water pollution control plants across Canada represents a major potential source of energy. Optimized utilization of this biogas could significantly reduce the operating costs associated with municipal wastewater treatment. A questionnaire designed to collect information on the current practices employed at municipal anaerobic digestion facilities in Canada was forwarded to contact personnel at each plant. Response to the questionnaires was 70%. The actual biogas production rates reported were compared to those calculated using the volatile solids loading rates reported at each plant. The actual biogas production rates were considerably lower than expected at small <25,000 m^3/d design flow and large (>100,000 M^3/d) sized plants and marginally lower than expected at medium sized plants. All plants surveyed indicated that they maintained a constant mesophilic (30 to 38 C) temperature in their primary digesters. Fifty-nine percent insulated their primary digesters and employed some form of digester mixing. Thirteen percent heated their secondary digesters and 54% insulated them. Seventy five percent of the plant stated that they used produced biogas to fuel boilers and heat their digestion tanks and/or control buildings. Ten percent used their biogas to fuel engine generator sets to produce electricity and heat. The remainder flared the biogas produced at their plants. The information which was collected will be used to develop biogas utilization strategies for municipal wastewater treatment plants. 9 refs., 4 figs., 7 tabs.

22074 (PB–90-131301/XAB) **Development of small gas-turbine-based steam cogeneration system. Phase 1. Final report, July 1987-December 1988.** Hagler, R.E. Teledyne Continental Motors, Mobile, AL (USA). Aircraft Products Div. Jan 1989. 218p. Available from NTIS, PC A10/MF A02.

The increasing cost of electricity, the availability of low-cost natural gas and the promotion of cogeneration by the Federal Energy Regulatory Commission has increased the attractiveness of cogeneration as an alternate energy source. A study of the commercial/military/industrial segments indicates a viable market for the proposed system in hotels/motels, hospitals, nursing homes, shopping centers, district-heating plants, military bases, and light manufacturing. Design analysis indicates that a packaged cogeneration system utilizing the Teledyne Continental Motors TP500 gas-turbine engine, developed as a low-cost aircraft engine, when modified to include an industrial gearbox, exhaust recuperator with variable bypass and single can combustor with dual fuel capability can compete favorably in cost, durability and fuel consumption with current converted diesel engine powered systems with the advantage of producing 100 psig steam at variable rates.

22075 (PB–90-131533/XAB) **Cost-benefit analysis of variable-speed generators applied to peakshaving/cogeneration systems. Topical report, December 1988-May 1989.** Lauw, H.K.; McArthur, R.C.; Marckx, D.A. Electronic Power Conditioning, Inc., Corvallis, OR (USA). Jul 1989. 105p. Available from NTIS, PC A06/MF A01.

Variable-speed operation of engine-generator sets can achieve maximum fuel efficiency at any rpm, taking advantage of the engine's ability to operate at speeds above (and below) the normal, fixed speed. Thus, it is possible to produce more power for a given engine size, reduce operating costs, and, in many cases, reduce capital costs for a given power rating. Two approaches to variable-speed generation are considered: one approach using a doubly-fed machine plus a power converter and another approach using a conventional generator plus a power converter. In the capital cost and operating cost comparisons the approach using a doubly-fed machine proves superior. The following figures apply to that approach. Constant operation at any level below full load results in operating cost savings with variable-speed generation. For 150 kW systems studied, variable-speed peakshaving can save from $4,000 to $8,000 in operating costs per year, and variable-speed cogeneration can save up to $24,000 in operating costs per year, assuming typical gas and electrical charges. Capital costs for the same systems can be reduced by as much as $5,000 for peakshaving and $8,000 for cogeneration.

22076 **Computer simulation of a municipal solid waste combustor.** Ahmed, S. (Argonne National Lab., IL (USA)); Kumar, R.; Helt, J.E. *JAPCA, the International Journal of Air Pollution Control and Hazardous Waste Management (USA),* 39(10): 1328-1333 (Oct 1989).

A mathematical model has been developed to study the thermal and chemical processes occurring in a municipal solid waste mass combustor. Treating the solids feed as a mixture of pseudo-components, the model determines the interrelationships between the solids feed rate, grate travel rate and length, amounts and distributions of primary and secondary air, extent of solids burn out, and the bed and flame temperatures. The model incorporates the kinetics of pyrolysis of solids and simulates heat and mass transfer within the bed. The temperature and mass flow profiles generated show that much of the grate is taken up by the heatup and burnout zones. The heatup zone can be reduced by distributing the primary air to maintain minimal air flow in that region, thereby permitting rapid heatup. Increasing the solids feed rate and adjusting the air flow distributions can reduce the length of the burnout zone. The computer program, available on both PCs and mainframe, can be used for different MSW incinerator dimensions and feed parameters to investigate the effects of the control variables and optimize the desired output characteristics, e.g., maximize solids throughput.

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 22074, 22082, 22086, 22090, 22163

22077 (AD-A–214533/2/XAB) **Development of a T53-l11 engine computer model. Propulsion technical memo.** Faragher, J. Aeronautical Research Labs., Melbourne (Australia). Apr 1989. 42p. (ARL-PROP-TM–453). Available from NTIS, PC A03/MF A01.

This Technical Memorandum describes the development of a steady-state engine model for a Lycoming T53 turboshaft engine. A genuine compressor map obtained from Lycoming was integrated into a generic gas-turbine modeling program called Turbotrans. Both engine performance predictions and the variation of output power with free turbine speed showed good correlation with manufacturer's data. The ability to simulate engine wear and damage via degraded component efficiencies was demonstrated but not validated.

22078 (AD-A–214770/0/XAB) **Analysis of enclosed internal-combustion-engine operation with water as the working fluid. Technical note.** Rein, C.R. Naval Ocean Research and Development Activity, NSTL, MS (USA). Sep 1983. 23p. Available from NTIS, PC A03/MF A01.

It is desirable to develop a totally enclosed system that contains an internal combustion engine and all the accessories required to produce at least 480 hp-hr of work. The system must perform underwater without external support and must release nothing but heat to the water. Most prior development has dealt with systems very similar to air breathing engines. Fuel, oxygen and a diluent gas such as nitrogen are ingested through the same kinds of intake devices used in the atmosphere. The intent is to imitate open air operation as much as possible in order to reduce hardware development. The exhaust gases are cleansed primarily of the water and carbon dioxide products of combustion and perhaps secondarily of other components such as unburned hydrocarbons, carbon monoxide, and compounds produced by reactions involving the diluent.

22079 (ANL/ESD/TM–2) **A technical and economic evaluation of oxygen-enriched combustion in diesel engines using water-emulsified fuels.** Cole, R.L.; Marciniak, T.J.; Sekar, R.R.; Stodolsky, F. Argonne National Lab., IL (USA). Energy Systems Div. Jan 1990. 75p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90008095. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The technical and economic feasibility of using oxygen-enriched air and low-grade fuels in diesel cogeneration systems is reported. The effects of oxygen enrichment, low-grade fuels, and water addition on the combustion process were studied using first principles of combustion theory; the effects of oxygen enrichment and water addition on diesel engine performance were analyzed with a computer model; air separation technologies were evaluated; the coupling of the oxygen plant to the diesel engine was studied; and the internal rate of return for several system options was determined. The greatest improvement in economic benefits is obtained primarily from fuel switching, and the optimal oxygen enrichment is the minimum that will enable medium- and high-speed diesel engines to use low-grade fuels. Two oxygen-enrichment technologies, selective membranes and pressure-swing adsorption, were identified as being both technically and economically feasible. Oxygen enrichment increases the power of the diesel engine by allowing an increased fueling rate, although increased pressures and temperatures may decrease engine life. Oxygen enrichment decreases CO, smoke, and particulate emissions from the engine but increases NO_x emissions. However, the NO_x emissions, pressures, and temperatures can be controlled by water addition and fuel-injection timing adjustments. 53 refs., 33 figs., 20 tabs.

3302 External Combustion Engines

22080 (DOE/NASA–0282-1) **Identification of a cast iron alloy containing nonstrategic elements: Final report.** Cooper, C.V. (United Technologies Research Center, East Hartford, CT

(USA)); Anton, D.L.; Lemkey, F.D.; Nowotny, H.; Bailey, R.S.; Favrow, L.H.; Smeggil, J.G.; Snow, D.B. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center; United Technologies Research Center, East Hartford, CT (USA). Jun 1989. 74p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AI01-77CS51040. (NASA-CR–185174;R–89-917447-32). Order Number DE90008025. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A program has been carried out to address the mechanical and environmental needs of Stirling engine heater head and regenerator housing components, while reducing the dependence on strategic materials. Current candidate materials for such applications contain significant levels of cobalt, nickel, chromium, and/or tantalum. An alloy was developed during this program which contained none of these strategic elemental additions per se. The base is iron with additions of manganese, molybdenum, carbon, silicon, niobium, and ferro-chromium. Such an alloy should be producible on a large scale at very low cost. The resulting alloy, designated as NASAUT 4G-A1, contained 15 Mn, 15 Cr, 2 Mo, 1.5 C, 1.0 Si, 1.0 Nb (in weight percent) with a balance of Fe. This alloy (and several others along the development path) was optimized for chemistry, based upon tensile strength, creep-rupture strength, fracture behavior, and fatigue resistance up to 800°C. Alloys were also tested for environmental compatibility (in air, salt fog, and hydrogen). The microstructure and mechanical properties (including hardness) were assessed in the as-cast condition and following several heat treatments, including one designed to simulate a required braze cycle. The alloy was fabricated and characterized in the form of both equiaxed and columnar-grained castings. The columnar grains were produced by directional solidification, and the properties were characterized in both the longitudinal and transverse orientations. The NASAUT 4G-A1 alloy was found to be good in cyclic-oxidation resistance and excellent in both hydrogen and hot-corrosion resistance, especially in comparison to the baseline XF-818 alloy. 12 refs., 42 figs., 20 tabs.

3303 Electric-Powered Systems

Refer also to citation(s) 21875, 21885, 21949

22081 (EPRI-CU–6685) **Assessment of US electric vehicle programs with ac powertrains: Final report.** Kevala, R.J. (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA). Transportation Consulting Div.). Electric Power Research Inst., Palo Alto, CA (USA); Booz, Allen and Hamilton, Inc., Bethesda, MD (USA). Transportation Consulting Div. c Feb 1990. 151p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

AC powertrain technology is a promising approach to improving the performance of electric vehicles. Four major programs are now under way in the United States to develop ac powertrains: the Ford/General Electric single-shaft electric propulsion system (ETX-II), the Eaton dual-shaft electric propulsion system (DSEP), the Jet Propulsion Laboratories (JPL) integrated ac motor drive and recharge system, and the Massachusetts Institute of Technology (MIT) variable reluctance motor (VRM) drive. The JPL program is sponsored by EPRI; the other three programs are funded by the US Department of Energy. This preliminary assessment of the four powertrain programs focuses on potential performance, costs, safety, and commercial feasibility. Interviews with program personnel were supplemented by computer simulations of electric vehicle performance using the four systems. Each of the four powertrains appears superior to standard dc powertrain technology in terms of performance and weight. The powertrain technologies studied in this assessment are at varying degrees of technological maturity. One or more of the systems may be ready for incorporation into an advanced electric vehicle during the early 1990s. Each individual report will have a separate abstract. 5 refs., 37 figs., 29 tabs.

3307 Emission Control

22082 (OI–CE02872, pp. 270-298) **The Deutz particulate trap system in a status report.** Sauerteig, J.E. (Deutz Corp., Atlanta, GA (USA)). Ortech International, Mississauga, ON (Canada). Oct 1989. (CONF-890682–: 5. Windsor workshop on alternative fuels, Windsor (Canada), 12-15 Jun 1989; CE–02872). In *Proceedings of the fifth Windsor workshop alternative fuels.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The paper describes the carcinogenic and mutagenic effects of Diesel engine emission. It then describes two types of particulate trap systems developed at KHD Deutz to reduce particulate emmissions. A system with external regeneration is available for engines up to 80 HP; it contains an uncatalyzed ceramic monolith and is regenerated by electric heating with air blowing. Systems with automatic regeneration comprise the by-pass system, which uses ceramic substrates with or without a catalyst, and the full-flow system, which uses an integrated burner. Emission measurements for a city bus equipped with a by-pass system with automatic regneration are given. The advantages of these products are listed. The paper is largely composed of slides, and the systems are only summarily described. 14 figs.

22083 (PB–90-856642/XAB) **Automobile air pollution: Automotive fuels. August 1970-January 1990 (Citations from the NTIS data base). Report for August 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 176p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855373.

This bibliography contains citations concerning the utilization of fuels and fuel additives for the reduction of automotive air pollution. Alternative fuels discussed include gasohol, methane, natural gas, and hydrogen. Improvements to gasoline and its properties which affect air pollution are considered, as well as lead and other fuel additives. (This updated bibliography contains 338 citations, 40 of which are new entries to the previous edition.)

3308 Alternative Fuels

Refer also to citation(s) 21893, 22083

22084 (BCR–TE-87-10) **Particulate emissions of a dual fuel caterpillar 3208 engine.** B.C. Research, Vancouver, BC (Canada). Apr 1987. 38p. (MICROLOG–89-05373). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The particulate emissions have been determined for a normally aspirated Caterpillar 3208 engine operating on diesel and dual fuel (diesel/natural gas). All tests were steady state measurements using a mini-dilution tunnel. When operating on dual fuel a microprocessor-based engine control system was used. This system allowed the engine to operate with the same torque curve on dual fuel as with diesel. The dual fuel control system varied the relative amounts of diesel fuel and natural gas used dependent on speed and load. The maximum load operation the dual fuel particulates were always lower than the diesel particulate emissions. The reduction in particulate emissions were as much as 85 % of the normal diesel emissions. For part load operation the dual fuel particulate emissions were always less than or equal to the diesel emissions. As shown in the particulate vs load curve, the emissions are dependent on the amount of diesel fuel used. To determine the nature of this relationship the data were analyzed to express the particulate emission as a function of diesel flow rate. The results indicate that to minimize particulate emissions it is necessary to minimize diesel flow rate. Therefore in the design of a duel conversion, from a particulate emissions viewpoint, it is necessary to maximize the substitution of diesel fuel. 13 refs., 13 figs., 1 tabs

22085 (OI–CE02872, pp. 299-303) **15 years of alternative fuels: Reflections, observations and predictions.** Ecklund, E.E. Ortech International, Mississauga, ON (Canada). Oct 1989. (CONF-890682–: 5. Windsor workshop on alternative fuels, Windsor (Canada), 12-15 Jun 1989; CE–02872). In *Proceedings of the fifth Windsor workshop alternative fuels.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This paper consists of informal observations on the future of alternative fuels. From the evaluations made by numerous countries, two conclusions emerge: if only a single fuel were to replace gasoline and Diesel fuel, then, the only indigenous resources sufficient to support highway vehicles would be either coal or oil shale; and the most likely alternative fuels are, in descending order; synfuels from oil shale and coal, methanol from coal and, possibly in the long term, hydrogen. Since 1974, technologies for use as near-term options, including natural gas and liquid petroleum gases, have been developed. Alternative fuels are of interest to the industry because they promise: energy security and reduced environmental impact. The practical activities in alternative fuels are now in the market-oriented phase, with 2 thrusts: commercial introduction and public policy. It is necessary to build a research and development (R&D) support base for alternative fuels to provide balance in relation to petroleum R&D: no single technology will provide the total benefits desired for both environmental and energy needs. The budget in the Department of Energy for alternative fuels utilization R&D is, typically, about 5% of the transportation technology budget.

22086 (OI–CE02872, pp. 258-269) **Developments of gaseous fuels in light duty and heavy duty vehicles in the Netherlands.** Weide, J. van der; Tiedema, I.P. Ortech International, Mississauga, ON (Canada). Oct 1989. (CONF-890682–: 5. Windsor workshop on alternative fuels, Windsor (Canada), 12-15 Jun 1989; CE–02872). In *Proceedings of the fifth Windsor workshop alternative fuels.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

Liquefied petroleum gas has been used in cars and vans in the Netherlands since the 1950s. The paper gives an overview of the engine equipment used in the past and currently under development. The performance of dual-fuel systems in which the Diesel fuel is partially substituted by gas while the original Diesel performance is maintained is discussed. Especially in view of stringent emission limits, gaseous fuels may offer interesting opportunities for application in city buses. Otto-cycle engines which use liquefied petroleum gas or compressed natural gas as sole fuel are described. Stiochimetric and lean gas combustion are compared, and the trade-off between nitrogen oxides emission on the one hand and carbon dioxide and hydrocarbons emission on the other hand is discussed as a function of the oxygen content in the exhaust gases. Examples of buses or trucks using dual-fuel or pure gas engines in various countries are presented. A sharp cost increase of engine equipment is expected, in the near future due to the introduction of microelectric emmission control systems. 5 refs., 8 figs., 3 tabs.

22087 (OI–CE02872, pp. 350-361) **NGV developments worldwide.** Parker, W.P. Jr. Ortech International, Mississauga, ON (Canada). Oct 1989. (CONF-890682–: 5. Windsor workshop on alternative fuels, Windsor (Canada), 12-15 Jun 1989; CE–02872). In *Proceedings of the fifth Windsor workshop alternative fuels.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The paper recalls the creation of the International Association of Natural Gas Vehicles (IANGV) in 1986. The IANGVs purpos is to foster the sharing of world-wide information and expertise regarding natural gas vehicles (NGV) for the purpose of enhancing the development of NGV equipment, regulations, utilization, and of the overall NGV market. Today, there are 130 members who meet at an international conference every 2 years. Concerns for the environment and for energy independence are growing world-wide and favor the use of natural gas; natural gas is also competitive with petroleum as to cost. The financial incentives of some countries towards the use of the NGVs are recalled. There are currently 500,000 to 600,000 NGVs in the world. The situations of Italy, Canada, Australia, New Zealand, the Netherlands, Sweden, Denmark, France, China, the Soviet Union, Argentina and other developing countries regarding the number of vehicles and filling stations are reviewed. The case of the United States is treated in more detail, including, the consequences of the Clean Air Act on the transportation sector. While price fluctuations can temporarily slow development, natural gas is recognized and supported for its place in the world energy picture as a viable, clean, safe and economical transportation fuel.

22088 (RFW–89-06086) **Hamilton Street Railway compressed natural gas bus demonstration project: Final report on phases 1-3.** Duncan, R.W. (Hamilton Street Railway (Canada)). Webb (R.F.) Corp. Ltd., Ottawa, ON (Canada). Sep 1988. 71p. (MICROLOG–89-06086). Available from PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A demonstration project on the feasibility of operating compressed natural gas (CNG) buses in an Ontario city has been completed. A fleet of diesel buses was converted to CNG, using spark-ignition CNG engines prepared by Iveco (Fiat), a fuel storage system comprising 7 fibre-wound aluminum cylinders, and other in-vehicle equipment. The CNG buses were fuelled from a compressor and operated over 245,000 km under regular service conditions. The requirements for a 5-minute bus refuelling operation were identified. The CNG buses performed at least as well as diesel buses of the same model and year, although range was limited in severe winter conditions. The safety record and driver acceptance were excellent. The demonstration defined the technical requirements and improvements which should be incorporated in future CNG bus designs to improve engine durability and ease of maintenance. Fuel utilization tests and current costs for natural gas and diesel fuel indicated that the CNG bus will provide transit service at a lower fuel cost than the current technology diesel bus. Fuel costs in the CNG bus will be substantially lower than those in diesel buses to be sold after 1990 when new bus emission standards are introduced. The total operating cost of the prototype CNG fleet, including retrofitting, was higher than that of the standard diesel fleet in the demonstration period. The technical changes in the CNG bus and changes in the refuelling system defined in the demonstration offer the prospect of lower total costs for CNG buses than the diesel buses operated in the future. The equipment and engine setup needed to control exhaust emissions to comply with anticipated post-1990 urban bus emission standards was identified. The low particulate emissions of the CNG engines were verified. 6 figs., 10 tabs.

22089 (RFW–89-06087) **Executive and technical summary report on propane bus demonstration-Ottawa-Carleton Regional Transit Commission.** Jenkins, W.D. Webb (R.F.) Corp. Ltd., Ottawa, ON (Canada). Mar 1988. 138p. (MICROLOG–89-06087). Available from PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A 37-month demonstration program has been completed of the use of propane-fuelled buses in revenue service in the Ottawa, Ontario region. Data on the safety, operation, maintenance, and economics of the 10 buses in the propane fleet were compared with data from a 12-month monitoring of a fleet of 10 diesel-engined buses of the same age and type. Rider and driver response were also assessed. The propane buses were operated over 1.4 million km of revenue service, transporting some 2.5 million passengers. The overall assessment has been that propane buses provided a satisfactory level of performance compared to the diesel buses under the conditions of the demonstration and current requirements. Public acceptance of the propane buses was not less than that of the diesel buses. The safety record of the buses and the refuelling facility was very good. The propane buses provided a level of availability comparable to that of the diesel buses, but more staff effort was needed to provide the required availability. The direct operating costs of the propane buses were only marginally lower than those of diesel buses; the low cost of propane was offset by the higher volumes used, particularly the propane consumed during extended warmups on winter mornings. The maintenance costs of the propane fleet were substantially higher than for the monitored diesel fleet, in part due to high wear

and unsatisfactory durability experienced in the carburation equipment, and in part to the high demand load on electrical equipment associated with outdoor winter parking. Future legislation to limit emissions from buses is expected to increase the cost of diesel buses relative to propane buses due to the more complex emission control devices needed for diesel buses. 10 figs., 24 tabs.

22090 Combustion and performance characteristics of methanol plus higher alcohols in a spark ignition engine. 106p. Coordinated Science Laboratory, Urbana, IL (1987).

Technical Paper ILENR/AE-87/03.

The composition of alcohol fuels derived from coal and other sources depends upon the manufacturing process, process operating conditions, and properties of the raw material. The alcohol blend which is representative of the product which could be obtained from a methanol synthesis process using a non-selective catalyst contains by volume, 75% methanol, 5% ethanol, 7.5% 1-propanol, and 12.5% 2-methyl-1-propanol. This composition of alcohols was used as the methanol plus higher alcohols (MPHA) fuel. Because of different compositions of indolent-methanol blends and indolene-MPHA blends, and physical properties and performance parameters need to be examined at various operating conditions. The fuel specifications, are listed. The objective of this work is to investigate the physical and chemical properties of MPHA-indolene blends, and the combustion characteristics.

35 ARMS CONTROL

22091 (AD-A-214751/0/XAB) **Key themes in Soviet published sources on the Federal Republic of Germany.** Clark, S.L. Institute for Defense Analyses, Alexandria, VA (USA). Sep 1989. 28p. Available from NTIS, PC A03/MF A01.

IDA Independent Research Program.

This paper examines Soviet assessments of the Federal Republic of Germany's (FRG) security policy during the Gorbachev period. In this context, the main issues discussed in the Soviet open-source literature are: nuclear weapons; West German defense cooperation with France; the FRG's role in NATO; Soviet-West German relations; the German question and revanchism; and arms control. Soviet assessments of the FRG have clearly become more positive in the past two years. In short, the Gorbachev leadership recognizes the fundamentally important role the FRG plays in the West and between East and West.

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 22330

3502 Proliferation

22092 (ERCI-R-88-93) **Key nonproliferation issues.** ERC International, Fairfax, VA (USA). 29 Dec 1988. 275p. Sponsored by U.S. DOE Assistant Secretary for International Affairs and Energy Emergencies; U.S. DOE Management & Administration. DOE Contract AC01-86IE10509. Order Number DE90007553. Available from NTIS (US Sales Only), PC A12/MF A01 - OSTI; GPO Dep.

In the series of papers that follow, the reader is provided with an overview of the major features of the international non-proliferation regime, of the US non-proliferation policies and programs; and most importantly, of several of the major issues in the non-proliferation and nuclear export area that are likely to confront the Bush Administration when it assumes office.

3503 Verification

Refer also to citation(s) 22479, 22481, 22795

22093 (UCID-21818) **Deterrence of arms control treaty evasion by suspect site inspections.** Lippitz, M.J.; Strait, R.S. Lawrence Livermore National Lab., CA (USA). Nov 1989. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008037. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Deterrence of evasions is an important benefit of arms control treaty verification measures in general, and suspect site inspections in particular. In this report, we present an analytical framework for evaluating the deterrence effect of verification measures and discuss the framework in the context of suspect site inspections. The framework incorporates the effects of verification measures on both the probabilities of detection and the evader's values of evasion. 6 refs., 13 figs.

36 MATERIALS

Refer also to citation(s) 22063, 22287, 22288, 22289

22094 (ORNL/FMP-89/2) **Fossil Energy Advanced Research and Technology Development Materials Program: Semiannual progress report for the period ending September 30, 1989.** Judkins, R.R.; Braski, D.N. (comps.). Oak Ridge National Lab., TN (USA). Jan 1990. 633p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90008393. Available from NTIS, PC A25/MF A01 - OSTI; GPO Dep.

This Program includes research aimed toward a better understanding of materials behavior in fossil energy environments and the development of new materials capable of substantial enhancement of plant operations and reliability. This combined semiannual progress report of activities on the Program is in accordance with a work breakdown structure in which projects are organized according to materials research areas. These areas are (1) Ceramics, (2) New Alloys, (3) Corrosion and Erosion Research, and (4) Technology Development and Transfer. Individual projects are processed separately for the data bases.

22095 (VTT-TIED-744) **Nuclear fuel materials research project.** Hansson, L. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Metallilaboratorio); Lunabba, R.; Planmann, T.; Vitikainen, E. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Aug 1987. 50p. (In Finnish). Order Number DE90619344. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The aim of the research has been to produce information and develop our own testing resources related to new fuel designs, behaviour of present fuel designs, fuel inspection methods and control rod materials. At the Technical Research Centre of Finland (VTT) the nuclear fuel materials programme has produced data which have been utilized in procurement, behavioural analysis and surveillance of the fuel used in the Finnish nuclear power stations. In addition to our own experience, data on fuel behaviour have been received by participating in the international cooperation projects, such as OECD/Halden, Studsvik-Ramp-programmes, IAEA/BEFAST and VVER-fuel research projects. The volume of the research work financed by the Finnish Ministry of Trade and Industry (KTM) and the Technical Research Centre of Finland in the years 1984-1986 has been about 9 man years. The report is the summary report of the research work conducted in the KTM-financed nuclear fuel materials programme in the years 1984-1986.

3601 Metals and Alloys

Refer also to citation(s) 21120, 21165, 21169, 21512, 21524, 21694, 21699, 21700, 21706, 21725, 21728, 21738, 21775, 21830, 21835, 21836, 21839, 21842, 21879, 21915, 22033, 22080, 22136, 22147, 22170, 22173, 22202, 22241, 22257, 22476, 22856, 23074, 23105, 23140, 23141, 23142, 23143, 23144

22096 (AD-A-214061/4/XAB) **Advanced tribological coatings for high-specific-strength alloys. Interim report No. 5.** Vine, M.K. National Centre of Tribology, Risley (UK). 29 Sep 1989. 121p. (NCT-3789/607). Available from NTIS, PC A06/MF A01.

Availability: Document partially illegible.

The objectives of this contract are to develop and test a surface treatment suitable for the hardening of a titanium alloy precision gear for use in a vacuum environment. Attention was primarily directed at surface hardening by the interstitial diffusion of the elements nitrogen, oxygen and carbon. Targets of a surface hardness

of >500 HV and depth 50 microns, without the need of any post-heat-treatment operations were identified. The surface treatments under study were applied to specimens of IMI 318 (Ti6Al4V), cut from plate. The sample numbers and corresponding surface treatments carried out and tested to date are listed. SHT indicates that the plates sample was in a solution heat treated condition before surface treatment.H&G indicates that the sample was in a hardened and ground condition before surface treatment.

22097 (AD-A–214701/5/XAB) **Ion-beam modification of metals: Mechanical properties and structure. Final report, 15 August 1986-14 August 1989.** Mayer, J.W. Cornell Univ., Ithaca, NY (USA). 1 Oct 1989. 9p. Available from NTIS, PC A02/MF A01.

The objective of this work was to study the phase transformations and property changes of metals bought about by ion-beam-induced materials modification and then to use this information to produce stable surface layers exhibiting optimal chemical and mechanical integrity. Summary of most significant Results: (1) Amorphous alloys can be formed by ion mixing a wide variety of metal systems within defined regions of atomic composition. (2) Two step processing such as implanting carbon and nitrogen into ion-beam-mixed layers improves the friction behavior. (3) Iron-titanium mixed on stainless steel and implanted with N and C results in a wear-resistant layer that deforms to depths greater than the thickness of the modified layer. (4) These novel structures on stainless steel were used to demonstrate a technique for distinguishing between deformation and material removal on worn surfaces. (5) Mixing substantial amounts of gold into Ti improves corrosion resistance of the Ti without appreciably degrading the wear and friction behavior.

22098 (AD-A–214922/7/XAB) **Experimental evaluation of new alloy coatings. Final report, November 1986-January 1989.** Lee, K.N.; Worrell, W.L. Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Materials Science and Engineering. 19 Jul 1989. 51p. Available from NTIS, PC A04/MF A01.

The oxidation behavior of binary iridium-aluminum and iridium-hafnium alloys, and ternary iridium-aluminum-silicon, rhenium-aluminum-silicon, tungsten aluminum-silicon and molybdenum-aluminum-silicon alloys was investigated in 1 atm oxygen at 1550 C - 1800 C. Iridium-hafnium alloys form a protective hafnia scale at above 50 at % hafnium and iridium-aluminum alloys form a protective alumina scale at above 55% aluminum. Silicon decreases the aluminum concentration necessary for the formation of a protective alumina scale on irridium-aluminum alloys from around 55 to below 30 at %, and remarkably extends the lifetime of the alumina scale. Rhenium-aluminum-silicon, tungsten-aluminum-silicon, and molybdenum-aluminum-silicon alloys also exhibit good oxidation resistance, but the data are too sparse for any definite analysis or conclusions. The iridium-aluminum-silicon alloys with the aluminum concentration from 30 to 50 and the silicon concentration from 8 to 15 at% are proposed to be the best potential coating materials.

22099 (AGARD-LS–168, pp. 24) **Advances and future directions in superplastic materials.** Sherby, O.D. (Lockheed Missiles and Space Co., Palo Alto, CA (USA)); Wadsworth, J. Advisory Group for Aerospace Research and Development (AGARD), 92 - Neuilly-sur-Seine (France). Sep 1989. (AGARD-LS–154-REV;CONF-8910370–: Superplasticity conference, Rome (Italy), 5 Oct 1989). In *Superplasticity*. Available from NTIS, PC A11/MF A02.

New events are reviewed in the development and modeling of superplastic materials. Over the last several years, superplasticity was developed in fine microstructures in microduplex stainless steels, aluminum-lithium alloys, mechanically alloyed aluminum, silicon carbide whisker-reinforced aluminum alloys, aluminum-magnesium alloys, and nickel alloys. In the latter three cases, the phenomenon is observed at high strain rates by comparison with most superplastic alloys. In a major breakthrough, a ceramic (yttria stabilized zirconia) and a ceramic composite (yttria stabilized zirconia containing alumina) were shown to be superplastic in tension tests. Superplastic behavior in iron carbide was also observed. Superplastic studies are also underway in intermetallics such as nickel silicides, nickel aluminides, and titanium aluminides. New insights are becoming apparent in the area of modeling superplastic behavior by the integration, into existing models, of new concepts based on grain boundary sliding accommodated by slip and the influence of threshold stresses associated with grain boundary sliding. Newtonian-viscous flow can be approached in fine-grained Class 1 solid solution alloys. Significant advances were also made in understanding internal stress superplasticity; recent examples include zinc, alpha-uranium, zinc-alumina composites and silicon carbide whisker reinforced aluminum alloys. A new model has been proposed for internal stress superplasticity. In other major developments, the mechanisms of superplasticity were successfully applied to consolidation of powders and superplastic behavior was developed in ferrous-based laminated composites. Finally, some neglected areas offering the potential for superplastic flow are reviewed.

22100 (BNL–43791) **Surface-plasmon enhanced nonlinear photoelectric emission from thin silver films.** Tsang, T.; Srinivasan-Rao, T.; Fischer, J. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900530–7: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90007676. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report a 10^4 enhancement and quantum yield of 1.7×10^{-8} obtained from a 2–photon photoelectric emission of a thin silver film using surface plasmon excitation, which are resonantly pumped by femtosecond laser pulses in an attenuated-total-internal reflection configuration. 5 refs., 3 figs.

22101 (CEGB-RD-B–6032/R88) **The role of specimen temperature difference in the elevated temperature pitting/transfer of PE16 and 20/25/Nb SS during impact wear.** Morri, J. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Jan 1989. 21p. (AGR-CIF-TWG/P–(88)250;GEN-TBMSG-P–(88)6479/A/1). Order Number DE90619375. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A previous study of the impact fretting wear characteristics of $PE16^+$ impacting 20/25 Nb SS (carried out on the BNL twin vibrator rig) identified a pitting-transfer form of wear at 480°C. This behaviour was thought to be dependent upon the temperature difference $\Delta T(\Delta T = T_{20/25}\text{-}T_{PE_{16}})$ between the two specimens. In that series of tests, however, no localised temperature control over the specimens was possible and specimen temperature effects could only be assessed by interchanging their positions in the rig. The introduction of locally positioned auxilliary heaters permitted a degree of control over the specimen temperature difference. The effect of ΔT upon pitting and transfer of the PE16 and 20/25 was then assessed and is reported in this paper. The study confirmed that the pitting transfer process was dependent on the temperature difference between the two surfaces. The direction and size of the transfer/pitting effect was independent of the material. Under the particular set of conditions employed in the test, pitting occurred only when the magnitude of ΔT exceeded 20°C. At high ΔT the initial period of high friction was extended and was associated with the tendency for gross transfer and pitting. (author).

22102 (CEGB-RD-B–6143/R89) **Creep rupture properties of oxidised 20%Cr austenitic stainless steels.** Lobb, R.C.; Ecob, R.C. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Feb 1989. 24p. Order Number DE90619376. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Sheet specimens of stabilised 20%Cr/25%Ni/Nb and nitrided 20%Cr/25%Ni/Ti stainless steels, both used as fuel cladding materials in CAGRs, have been oxidised in simulated reactor gas (Co_2/1-2%CO) for up to l.9kh at 850°C, including intermediate thermal cycles to room temperature. The oxidised specimens have been creep tested subsequently at 750°C, under conditions of constant stress. The creep rupture properties are affected differently for the two materials. For 20%Cr/25%Ni/Nb stainless steel, there was no effect of oxidation on the intrinsic microstructure, when compared with thermally aged, non-oxidised material. Any differences in creep ductility were ascribed to geometric effects in specimens of this alloy. Lower ductilities were associated with an increased incidence of pitting attack (higher oxide spallation) and it was concluded that the extent of local, rather than general, loss of section

controlled the ductility. For nitrided 20%Cr/25%Ni/Ti stainless steel, the intrinsic microstructure was affected by oxidation, such that increased grain boundary precipitation of $M_{23}C_6$ occurred. The resultant effect was for a greater tendency for intergranular failure at lower ductility than for the thermally aged material. The magnitude of this reduction could not be quantified because the specimen geometry was also changed by oxidation. In this instance, the oxidation mode that produced the most severe loss of section was grain boundary, rather than pitting, attack. This mode of attack was not linked directly to oxide fracture/spallation, but to the period of oxidation. (author).

22103 (CEGB-TPRD-B–1049/R88) **AGR steel corrosion monitoring schemes: progress on off-site testing of coupon specimens to end of 1985: Pt. 1: Mild steel coupons.** Whittle, I.; Meredith, M.E. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1988. 36p. Order Number DE90619400. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Off-site Advanced Gas-cooled Reactor steel corrosion monitoring through experiments on mild steel coupon specimens is reported. The appearance of all mild steel coupons oxidised over the temperature range 375 to 450°C is consistent with what is expected for the appropriate silicon content, temperature and in the gas mixes used. Likewise, weight gain data from the tests is as expected and where linear (breakaway) oxidation kinetics are in evidence, measured rates are within one standard deviation of the mean oxidation rates predicted by the 1/R model. Also, data relating mean breakaway oxide thickness to weight gain is in good agreement with the currently recommended relationship of 1 mg cm^{-2} weight gain = 6.72 μm oxide thickness. The observed oxidation behaviour of the off-site mild steel coupons is consistent with the most recent design data. (author).

22104 (CONF-8905179–3) **Physical sputtering of metallic systems by charged-particle impact.** Lam, N.Q. Argonne National Lab., IL (USA). Dec 1989. 123p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 8. Pfefferkorn conference on fundamental beam interactions with solids for microscopy, microanalysis and microlithography; Park City, UT (USA); 7-12 May 1989. Order Number DE90007803. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

The present paper provides a brief overview of our current understanding of physical sputtering by charged-particle impact, with the emphasis on sputtering of metals and alloys under bombardment with particles that produce knock-on collisions. Fundamental aspects of ion-solid interactions, and recent developments in the study of sputtering of elemental targets and preferential sputtering in multicomponent materials are reviewed. We concentrate only on a few specific topics of sputter emission, including the various properties of the sputtered flux and depth of origin, and on connections between sputtering and other radiation-induced and -enhanced phenomena that modify the near-surface composition of the target. The synergistic effects of these diverse processes in changing the composition of the integrated sputtered-atom flux is described in simple physical terms, using selected examples of recent important progress. 325 refs., 27 figs.

22105 (DOE/ER/45061–6) **Theoretical and experimental study of solid phase miscibility gaps in III/V quaternary alloys: Progress report, April 1, 1987–June 2, 1989.** Stringfellow, G.B. Utah Univ., Salt Lake City, UT (USA). 2 Jun 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45061. Order Number DE90008430. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The first 8 years of this DOE supported research was directed toward understanding, for the first time, the thermodynamics of miscibility gaps and ordering in III/V alloys. This research has led to the publication of 32 papers in technical journals as well as 17 invited papers and national and international conferences. In addition, this work led directly to the invitation to organize the "Joint US/Japan Workshop on Alloy Semiconductor Physics and Electronics" held October 1988 in Hawaii. This report contains a brief project summary, a listing of papers and talks, and a section devoted to supported and graduated students.

22106 (DOE/ER/45310–20) **An investigation of the dislocation structure of the Ni/Ag phase boundary.** Bamford, T.A. (Wilkes Coll., Wilkes-Barre, PA (USA). Dept. of Engineering and Physical Science). Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering. Dec 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER45310. Order Number DE90008428. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Ni/Ag interphase boundary structure in the parallel cube-on-cube orientation was studied for the boundary planes (001) and (011). Coarsely spaced dislocations were found in all annealed interfaces; the origin of these was apparently differential thermal expansion of the bicrystal film. A detailed search for intrinsic periodic structure consistent with the O-lattice construction was made using x-ray diffraction, electron diffraction and transmission electron microscopy. No evidence for this could be found; such a relaxation, if present, is very weak. It is unlikely that such a small relaxation could account for relative energy minimum associated with the parallel cube-on-cube orientation found by previous investigators. 10 refs., 6 figs.

22107 (DOE/ER/45379–1) **Synchrotron studies of x-ray reflectivity from surfaces.** Pershan, P.S. Harvard Univ., Cambridge, MA (USA). [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45379. Order Number DE90007809. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report briefly discusses progress made last quarter. Wetting properties of mercury and gallium are discussed. 3 refs.

22108 (DOE/ID/12847–T1) **AISI [American Iron and Steel Institute] direct steelmaking program annual technical report for year ending November 29, 1989.** Aukrust, E. USDOE, Washington, DC (USA). 20 Dec 1989. 38p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-89ID12847. Order Number DE90008142. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The direct steelmaking program is proceeding essentially on schedule. The physical chemistry research programs at Carnegie Mellon University and the Massachusetts Institute of Technology, concerned with ore-slag, ore-melt, and melt-slag reactions, are proceeding on schedule and are generating information on reaction rates, gas evolution rates, and mass-transfer and heat-transfer rates that will help in understanding and modeling the smelting process. Laboratory modeling of the refining process assisted in the design of a pilot-scale continuous refiner. Several runs of the continuous refiner from late October to early December yielded data that are currently being analyzed. 19 figs.

22109 (EPRI-NP–6477) **Finite-element model of ultrasonic NDE [nondestructive evaluation].** Lord, W. (Colorado State Univ., Fort Collins, CO (USA). Dept. of Electrical Engineering). Electric Power Research Inst., Palo Alto, CA (USA); Colorado State Univ., Fort Collins, CO (USA). Dept. of Electrical Engineering. c Jul 1989. 194p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

An understanding of the way in which ultrasound interacts with defects in materials is essential to the development of improved nondestructive testing procedures for the inspection of critical power plant components. Traditionally, the modeling of such phenomena has been approached from an analytical standpoint in which appropriate assumptions are made concerning material properties, geometrical constraints and defect boundaries in order to arrive at closed form solutions. Such assumptions, by their very nature, tend to inhibit the development of complete input/output NDT system models suitable for predicting realistic piezoelectric transducer signals from the interaction of pulsed, finite-aperture ultrasound with arbitrarily shaped defects in the kinds of materials of interest to the utilities. The major thrust of EPRI Project RP 2687-2 is to determine the feasibility of applying finite element analysis techniques to overcome these problems. 85 refs., 64 figs., 3 tabs.

22110 (FhG-IWM-W–1/89) **Three-dimensional FE analyses of stress distributions in laterally notched compact specimens of 20 Mn Mo Ni 55.** Stoeckl, H. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.). Jan 1989. 53p. (In German). Contract DFG Schm 522/6-1. Available from

Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.). Available from Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.).

In order to test the influence of the thickness of the test piece on the failure of laterally notched compact specimens of 20MnMoNi55 in the temperature range of the transition from brittle to ductile failure, three-dimensional analyses with finite elements were carried out. Load-opening curves and J opening curves agree well with the measuring results. The local J values along the crack front, which is supposed to be straight, increase in the elastic area when approximating the lateral notches. With an increasing plastic deformation an approximately constant J distribution is obtained at first, then J decreases near the lateral notches especially if the specimens are thin. The stress component σ_z which stands vertically on the ligament and the multi-axiality factor h (h = hydrostatic stress/reference stress) show the same tendency. If the specimens are thin, σ_z and h decrease with the distance from the crack front faster than thick specimens. (orig.).

22111 (GAI–89-06232) **Evaluation of short crack arrest test techniques: Final report.** Graville, B.A. Graville Associates, Inc., Georgetown, ON (Canada). Jun 1989. 62p. Contract EMR 23440-8-9187/01-SQ. (MICROLOG–89-06232). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A review of test techniques for evaluating crack arrest performance of steels suitable for offshore and Arctic applications has been carried out. No universally accepted test method or method of analysis exists. Where the crack length is short, a static analysis may be adequate for many practical purposes, but a full dynamic approach is needed to explain the performance of long crack propagation/arrest behaviour. The type of test employed should be related to the crack arrest criterion selected and the mode of crack arrest. For long crack arrest under elastic-plastic conditions the dual plate (hybrid) large size tests are most appropriate. Few practical applications would experience crack arrest under plane strain conditions as in the compact crack arrest test. For manual applications, a short crack arrest criterion may be appropriate. Design of the short crack arrest specimen and testing rig is less critical than for large crack arrest tests. The short crack run suggests that a static analysis could be used. It is recommended that this type of test should be used for a program for evaluating steels intended for Arctic and offshore applications and for establishing the crack arrest capability of steels meeting the requirements of Canadian Standards Association Standard S473. A survey of available facilities indicates that suitable apparatus for most types of crack arrest tests are available in Canada, and minor modifications to the wide plate rig at the Welding Institute of Canada would make it suitable for short crack arrest tests. 26 refs., 37 figs., 2 tabs.

22112 (GKSS–89/E/22) **Results of fracture-mechanical studies on the steel X6CrNi1811.** Tietje, H.; Cornec, A.; Schwalbe, K.H. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 13p. (In German). (CONF-8902168–: 21. lecture meeting of the DVM Study Group on francture mechanisms: fracture-mechanical characteristics for structural components evaluation, Bad Nauheim (Germany, F.R.), 27-28 Feb 1989). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

Ductile breaking processes in partly and fully plastic material behaviour can be be characterized with the concepts of yield fracture mechanics. Various methods are available: (1) In the CTOD concept, the deformation at the crack tip (in particular, the crack-tip opening displacement δ_5) is seen as the criterion for material stress, and used as a fracture criterion. (2) The J integral can be used as a fracture parameter within certain ranges of validity; it describes the stress and displacement field ahead of the crack tip. It has been discovered that in a two-dimensional state of stress, an R curve shows a larger range of validity on a CTOD basis than on the basis of the J integral. In this study, these inter-connections are tested with the help of a material with a high degree of ductility and an extremely high crack resistance. To this end, measurements were performed with compact specimens (CT specimens) and with tensile test specimens (CCT specimens) from the austenitic steel X6CrNi1811 (material no. 1.4948), and the J-R and δ_5-R curves were determined (δ_5: crack-tip opening displacement with a measuring basis of 5 mm). (orig.).

22113 (GKSS–89/E/28) **Properties of wet welded joints.** Szelagowski, P.; Stuehff, H.; Loebel, P.; Blight, J.; Donelly, C.; Schafstall, H.G. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 12p. (CONF-890549–: 21. offshore technology conference and exhibition (OTC-21), Houston, TX (USA), 1-4 May 1989). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

The work presently reported is a part of a joint R and D program between GKSS Research Centre and Comex Services to develop a wet welding procedure for structural application. The main objective of the report is the presentation of so far evaluated results achieved in a wet welding test program down to a water depth of 100 msw. The paper reports about the comparison between weldment properties produced with ferritic and austenitic electrodes in a simulated dive and the achieved mechanical-technological weldment properties. The welds were performed in the flat position on steel plates, using RSt 52-3 (DIN 17100) as base metal. The selected consumables were readily available on market, but so far not applied to the tested depths. The evaluated results are encouraging, further developments and investigations are under progress. (orig.).

22114 (GKSS–89/E/29) **Properties of hyperbaric flux cored arc welds: Weld metal chemistry.** Santos, J.F. dos; Szelagowski, P.; Schafstall, H.G. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 13p. (CONF-890549–: 21. offshore technology conference and exhibition (OTC-21), Houston, TX (USA), 1-4 May 1989). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

A literature review on the factors affecting weld metal chemistry on hyperbaric flux cored arc welds (FCAW) has been carried out. The following aspects have been considered: shielding gas flow, shielding gas activity and oxidation/deoxidation reactions. It has been shown that the available knowledge allows an adequate selection of conditions leading to acceptable weld metal chemistry in hyperbaric FCAW. (orig.).

22115 (GKSS–89/E/31) **Microstructure and weld metal matching effects on heat affected zone toughness.** Kocak, M. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)); Es-Souni, M.; Schwalbe, K.H.; Chen, L. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 10p. (CONF-890325–: 8. international conference and exhibition on offshore mechanics and arctic polar engineering (OMAE-8), The Hague (Netherlands), 19-23 Mar 1989). Available from Special print from: Salama, M.M.; Bangaru, N.V.; Denys, R.; Rhee, H.C.; Toyoda, M. (eds.): Eighth international conference on offshore mechanics and Arctic engineering. Vol. 3. American Society of Mechanical Engineers, book no. I0285C - 1989, p. 623-631.

The effects of the microstructural features of the coarse grained heat affected zone (CGHAZ) on fracture behaviour and toughness properties were investigated in under- and overmatched weld metals. CTOD (with various notch orientations) and Charpy-V impact tests were carried out on CGHAZ of bead-on-plate submerged arc welds with weld metal yield strengths of 248, 620 and 964 MPa on a StE 460 C-Mn steel with a yield strength of 458 MPa. The microstructural features of the CGHAZ's of three mismatched weldments were determined in terms of microhardness surveys, martensite amount and grain size measurements of the CGHAZ's. Additionally, chemical composition gradient of CGHAZ was analyzed using the SEM-EDX system. From the experimental results the conclusion was drawn that the CTOD and Charpy impact toughness of the CGHAZ's depend not only on the microstructural

features of the CGHAZ but also on the yield strength of the adjacent weld metal; the latter in some cases may control the apparent toughness and fracture behaviour of the CGHAZ. Some possible mechanisms leading to the different amount of martensite formation in CGHAZ of the mismatching welds are also discussed. (orig.).

22116 (KAPL–4713) **The stress corrosion performance of diffusion bonded nickel base alloys.** Pyrbylowski, J.W.; Wittmeier, R.D.; Sherwood, W.J.; Floreen, S. Knolls Atomic Power Lab., Schenectady, NY (USA). [1989]. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC12-76SN00052. Order Number DE90008130. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Excellent mechanical strength can be achieved in diffusion bonded nickel-base alloys when approximately 0.01 mm of nickel is plated on the surfaces before bonding. However, rapid stress corrosion cracking takes place in the bond line region when such materials are tested in high purity water at 360°C. The failures are caused by the low concentration of chromium in the nickel-rich bond line region. Long-time high temperature anneals to diffuse chromium into the bond line dramatically improve the stress corrosion resistance. Measurements of the local chromium in the bond line and separate tests of Ni–Cr binary alloys show that chromium contents approaching that of the bulk alloy are necessary to eliminate the cracking susceptibility. 13 refs., 6 figs., 4 tabs.

22117 (KFK–4668) **Irreversible thermodynamics models and constitutive equations of the irradiation induced deformation and damage accumulating processes.** Wassilew, C. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen. Nov 1989. 190p. (In German). Order Number DE90759495. Available from NTIS (US Sales Only), PC A09/MF A01.

This report gives an overall evaluation of several in-reactor deformation and creep-rupture experiments performed in BR-2, FFTF, and Rapsodie on pressurised tubes of the stabilized austenitic stainless steels 1.4970, 1.4981, 1.4988, and the nickel base alloy Hastelloy-X. The irradiation induced deformation processes observed in the components operating in a neutron environment can be divided into two main groups: 1. volume conserving creep and 2. volumetric swelling. Since the observed deformation as well as damage accumulating phenomena are caused by the same constrained generated and free disposable point defects and helium atoms, it is obvious and advisable to analyze, and to model simultaneously the ensemble of the elementary mechanisms and processes effective at the same time. Phenomenological models based on the thermodynamics of irreversible processes have been developed, with the aim of: 1. grasping the partial relationships between the external variables and the response functions (creep, swelling, creep driven swelling, and time to rupture), 2. fathoming the rate-controlling mechanisms, 3. providing insight into the structural details and changes occurring during the deformation and the damage accumulating processes, 4. integrating the damage accumulating processes comprehensively, and 5. formulating the constitutive equations required to describe the elementary processes that generate plastic deformations as well as damage accumulation. (orig./MM).

22118 (LA–11746-MS) **Mechanical behavior of aged uranium-3/4 weight percent titanium alloy.** Armstrong, P.E.; Ellis, R.W.; Follansbee, P.S.; Garcia, D.C.; Lopez, M.F. Los Alamos National Lab., NM (USA). Apr 1990. 45p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008287. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The mechanical behavior of the uranium-3/4 weight percent titanium alloy in the aged condition has been characterized by tension, notched tension, and compression tests. These tests were made over a temperature range of −196°C to 80°C, at strain rates from .001 s^{-1} to 2000 s^{-1}. Metallography on selected samples using optical and scanning electron microscopes was used to identify fracture modes. Compression and smooth tensile tests showed a linear decrease in yield strength with increasing temperature, and for tensile tests, a linear decrease in ultimate tensile strength with increasing temperature. The corresponding tensile ductility was relatively constant at temperatures above 0°C, then decreased rapidly with decreasing temperature. Notched tensile tests showed a ductile-to-brittle transition at about −40°C. SEM photographs showed a mixture of ductile-dimple fracture and brittle cleavage areas in all notched tensile sample fracture surfaces. Fracture surfaces on smooth tensile test samples showed a ductile-dimple structure at 80°C, a primarily ductile-dimple structure with some long narrow cleavage facets at 24°C, and a mostly cleavage structure at −54°C. The mechanical threshold stress model was fit to yield stress data and the parameters for an equation describing yield stress as a function of temperature and strain rate were determined. 15 refs., 32 figs., 4 tabs.

22119 (LBL–28294) **Design and processing of strong-tough microcomposite steels.** Thomas, G. Lawrence Livermore National Lab., CA (USA). Dec 1989. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9004139–1: Poland steel conference, Krynica (Poland), 23-26 Apr 1990). Order Number DE90007764. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Microcomposite HSLA steels based on Fe/Cr/Mn/C have been designed as a result of sophisticated electron microscopy and microanalytic studies so as to consist of fine packet lath dislocated martensite and interlath austenite films in order to obtain steels with superior combinations of strength, fracture toughness, and formability. Such properties can be obtained directly by on-line controlled rolling and cooling directly in a hot mill, so that post tempering can be eliminated. For long products and plates of low to medium carbon compositions, the processing requires accelerated water cooling. Niobium is effective in increasing hardenability, in grain refinement, and without adversely modifying the microcomposite morphology of the steels. 28 refs., 18 figs., 3 tabs.

22120 (LBL–28405) **The metallurgical mechanisms of solder fatigue.** Morris, J.W. Jr.; Tribula, D.; Summers, T.S.E.; Grivas, D. Lawrence Berkeley Lab., CA (USA). Dec 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900271–2: NEPCON '90: National Electronic Packaging and Production conference, Anaheim, CA (USA), 26 Feb - 1 mar 1990). Order Number DE90008390. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thermal fatigue of solder joints is an important source of failure in electronic devices. Failures arise from the strain, most often in shear, imposed on the solder joint by the uneven thermal expansions of the joint constraining surfaces. Increased solder joint reliability and improved more fatigue resistant solders require an understanding of the metallurgical mechanisms operative during the fatigue cycle. The work that is reviewed here concentrates on the mechanisms of thermal fatigue and, in particular, their association with the solder microstructure. While the fatigue life of Pb-Sn solder joints is strongly dependent on operating conditions, the metallurgical mechanisms of failure are surprisingly constant for joints where the deformation occurs predominantly in shear at elevated temperatures and the solder exhibits the classic lamellar eutectic microstructure. Under these conditions, the shear strain in the joint is inhomogeneous and initiates a local recrystallization and softening of the solder microstructure. Fatigue cracks initiate in this softer microstructure to cause ultimate failure. The results outlined here identify and elucidate the role of the solder microstructure during thermal fatigue and suggest specific paths toward the design of superior solder alloys. 32 refs.

22121 (LBL-PUB–3078) **Crystal preparation at LBL 1976 to 1986.** Heppler, W. Lawrence Berkeley Lab., CA (USA). May 1989. 52p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007754. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Soon after some progress had been made in understanding the structure of solids and the relation of structures to physical properties of solids, attention has turned to understanding the boundaries of bulk materials, their surfaces. Aside from the intrinsic interest of the subject, the motivations for this study are many because many chemical processes, such as corrosion, catalysis, and adhesion to name a few are limited to the surface of bulk materials. The natural

starting point for such studies is oriented and polished single crystal surfaces, since these idealized terminations of the bulk are expected to present a minimal number of different surface atoms or chemical states to the outside world. This report is meant to be a quick guide for the uninitiated into the mysteries of crystal orienting, cutting and polishing. It is hoped that the worker can then avoid some of the many pitfalls along the way.

22122 (N–90-13819) **Mean stress and the exhaustion of fatigue-damage resistance.** Berkovits, A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Nov 1989. 18p. (NASA-TM–101311;E–4307;NAS–1.15:101311). Available from NTIS, PC A03/MF A01.

Mean-stress effects on fatigue life are critical in isothermal and thermomechanically loaded materials and composites. Unfortunately, existing mean-stress life-prediction methods do not incorporate physical fatigue damage mechanisms. An objective is to examine the relation between mean-stress induced damage (as measured by acoustic emission) and existing life-prediction methods. Acoustic emission instrumentation has indicated that, as with static yielding, fatigue damage results from dislocation buildup and motion until dislocation saturation is reached, after which void formation and coalescence predominate. Correlation of damage processes with similar mechanisms under monotonic loading led to a reinterpretation of Goodman diagrams for 40 alloys and a modification of Morrow's formulation for life prediction under mean stresses. Further testing, using acoustic emission to monitor dislocation dynamics, can generate data for developing a more general model for fatigue under mean stress.

22123 (N–90-14641) **Thermal fatigue durability for advanced propulsion materials.** Halford, G.R. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Oct 1989. 13p. (NASA-TM–102348;E–5057;NAS–1.15:102348;CONF-8910371–: Australian aeronautical conference, Melbourne (Australia), 9-11 Oct 1989). Available from NTIS, PC A03/MF A01.

A review is presented of thermal and thermomechanical fatigue (TMF) crack initiation life prediction and cyclic constitutive modeling efforts sponsored recently by the NASA Lewis Research Center in support of advanced aeronautical propulsion research. A brief description is provided of the more significant material durability models that were created to describe TMF fatigue resistance of both isotropic and anisotropic superalloys, with and without oxidation resistant coatings. The two most significant crack initiation models are the cyclic damage accumulation model and the total strain version of strainrange partitioning. Unified viscoplastic cyclic constitutive models are also described. A troika of industry, university, and government research organizations contributed to the generation of these analytic models. Based upon current capabilities and established requirements, an attempt is made to project which TMF research activities most likely will impact future generation propulsion systems.

22124 (N–90-14642) **A nonlinear high temperature fracture mechanics basis for strainrange partitioning.** Kitamura, T.; Halford, G.R. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Oct 1989. 17p. (NASA-TM–4133;E–4733;NAS–1.15:4133). Available from NTIS, PC A03/MF A01.

A direct link was established between Strainrange Partitioning (SRP) and high temperature fracture mechanics by deriving the general SRP inelastic strain range versus cyclic life relationships from high temperature, nonlinear, fracture mechanics considerations. The derived SRP life relationships are in reasonable agreement based on the experience of the SRP behavior of many high temperature alloys. In addition, fracture mechanics has served as a basis for derivation of the Ductility-Normalized SRP life equations, as well as for examination of SRP relations that are applicable to thermal fatigue life prediction. Areas of additional links between nonlinear fracture mechanics and SRP were identified for future exploration. These include effects of multiaxiality as well as low strain, nominally elastic, long life creep fatigue interaction.

22125 (PRM–CE02870, pp. 18) **Low temperature welding and corrosion of Arctic grade steels.** Luft, H.B. (Centre for Frontier Engineering Research, Edmonton, AB (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Manual field welding or modifications of Arctic offshore structures and vessels must frequently be performed at subzero temperatures. Since time is of the essence, savings n time and cost can be realized if these operations could be performed without the requirements of preheating the steel prior to welding. The modified, low-carbon and low carbon equivalent Arctic grade steels, do require lower preheating temperatures than conventional steels, although current welding procedures typically specify a minimum preheat of at least 0^0C. The repair welds must not degrade the brittle fracture resistance of the original fabrication and therefore must display adequate low temperature toughness. Furthermore, because the Arctic sea environment has shown to be appreciably corrosive, with weldments subjected to preferential attack, the field welds must also achieve acceptable seawater corrosion resistance. A manual welding procedure has been developed suitable for ambient temperatures as low as - 30^0C without preheating. To evaluate corrosion susceptibility, several laboratory tests have been conducted in simulated Arctic sea environments and some of the results are compared with in-situ tests being conducted on duplicate corrosion coupons attached to an Arctic offshore structure, a supply vessel, and a icebreaker. A scanning reference electrode technique has also been adapted to analyse the localized corrosion of test welds and to be used as a short term laboratory tool to assess the compatibility of any given combination of welding electrode and base plate steel. It is shown that by proper matching of a welding consumable to a given Arctic grade steel, the severity of preferential corrosion can be minimized. 9 figs.

22126 (RISO-M–2813) **Metallurgy Department publications 1988.** Schroeder Pedersen, A.; Bilde-Soerensen, J.B. (eds.). Risoe National Lab., Roskilde (Denmark). Aug 1989. 44p. Order Number DE90619343. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A presentation (including abstracts) of scientific and technical publications and lectures by the staff of the Metallurgy Department during 1988 is given. The list comprises journal papers, conference papers, reports, lectures and poster presentations in the following catagories: Publications, Lectures and Poster Presentations. (author).

22127 (SAND–89-1514C) **High temperature chemistry of oxide superconductors.** Aselage, T.L.; Keefer, K.D.; Voigt, J.A. Sandia National Labs., Albuquerque, NM (USA). [1989]. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8910120–8: 1. international ceramic science and technology congress, Anaheim, CA (USA), 31 Oct - 3 nov 1989). Order Number DE90007821. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A knowledge of the high temperature chemistry involved in the formation of the high-$T_c$superconductors is necessary in order to prepare materials with desired properties. We have studied the liquidus relations in the $YO_{1.5}$-BaO-CuO system and have performed initial experiments to understand equilibrium conditions in the Tl-Ca-Ba-Cu-O system. We shall review the liquid forming reactions that pertain to the processing of $YBa_2Cu_3O_{7-\delta}$, and show that the ternary peritectic reaction between CuO and $YBa_2Cu_3O_{7-\delta}$ generates a liquid phase that promotes deleterious grain growth of the superconducting phase. We shall also show that very small deviations in stoichiometry can have a large effect on microstructure through the generation of such liquids. Finally, we shall describe our approach to understanding the equilibrium conditions of the thallium-based superconductors. Under our experimental conditions, none of the superconducting phases exists in equilibrium

with thallium oxide at high temperatures; rather, thallium-rich oxides containing barium and/or calcium, but not copper, coexist with thallium oxide. 23 refs., 9 figs.

22128 (SAND–89-7096) **Evaluation of material homogeniety as a function of thickness of low-alloy ferritic steel: Final report.** Anderson, T.L. (Texas A and M Univ., College Station, TX (USA). Research Foundation); Lambert, M.A. Sandia National Labs., Albuquerque, NM (USA); Texas A and M Univ., College Station, TX (USA). Research Foundation. Nov 1989. 35p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008069. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A series of Charpy and nil-ductility transition temperature (NDTT) tests were performed on 8 in. and 12 in. thick forgings of A508-4A, A508-4B, and A350-LF3 steels. Three different positions in thickness were tested in the 12 in. forgings, while two locations in the forging were analyzed. Chemical analysis and metallographic examination were also performed on each material and in each thickness location. The material toughness tended to be lower in the thicker forgings and in the center of a given forging. Low relative toughness coincided with well tempered microstructures, where equiaxed ferrite grains had begun to form. These grains are coarser than the packet structure that existed at earlier stages of tempering. Low quench rates (associated with thick sections and central regions of a given thickness) apparently accelerated the structural changes during tempering, which led to microstructures with low toughness. The NDTT results were suspect because most arrests occurred in the heat affected zones (HAZs) of the welds rather than in the parent metal. The measured NDTT values were lower than expected, based on published empirical correlations with Charpy energy. This was particularly true for the A508-4A steel. This provided further evidence that the drop weight tests were actually measuring the arrest properties of the HAZ in most cases. The fact that NDTT values were lower than expected is particularly surprising since the anvil test fixture was machined with a deflection stop 25 percent higher than the standard value.

22129 (UCID–21823-Rev.1) **A review of the literature on the toxicity of rare-earth metals as it pertains to the engineering demonstration system surrogate testing: Revision 1.** Wald, P.H. Lawrence Livermore National Lab., CA (USA). Jan 1990. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008049. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Considerable data on the toxicology of the rare-earth metals and their compounds via oral ingestion or injection have been collected from animal studies at relatively high exposure levels. This report includes a general introduction to the rare-earth elements, data reviews on the toxicity of the rare earths from animal studies and the relatively rare occurrences of harmful human exposure, precautions for worker protection that should be taken with use of these materials, and scientific data with EDS operations. 38 refs., 7 tabs.

22130 **Optical diagnostics for metallurgical processes.** Williamson, R.L. (Sandia National Labs., Albuquerque, NM (USA)); Peebles, H.C.; Hareland, W.A.; Zanner, F.J. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

Many industrially important metallurgical processes are accompanied by the emission of light, the analysis of which often supplies useful information concerning the current state of the process while also providing insight into the details of the specific process mechanisms. Optical diagnostic techniques are finding an increasingly wide range of application throughout the metallurgical community. This paper discusses the application of emission spectroscopy and imaging techniques to the analysis of such diverse processes as vacuum arc remelting, laser welding, and arc welding. A discussion of these techniques is presented addressing such subjects as instrumentation, data analysis, the kind of information available and its potential impact on the selection of process parameters. Special attention given too discussing the difficulties encountered in applying these diagnostic technologies to real life processes in non-laboratory environments.

22131 **Diagnostic techniques for PACVD systems for depositing protective coatings.** Roman, W.C. (United Technologies Research Center, East Hartford, CT (USA)); Stufflebeam, J.H.; Eckbreth, A.C. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

PACVD techniques for depositing protective coatings are an emerging field in plasma processing technology. Technology transfer is limited by a lack of understanding of the basic mechanisms involved in the gas phase plasma chemistry. The aspects of plasma species concentration and distribution and plasma gas temperature are fragmentary and unclear. Laser diagnostic techniques represent a critical starting point for providing some of this needed information. The techniques are in-situ, nonintrusive, and give excellent spatial and temporal resolution. Numerous diagnostic techniques for detailed coating characterization are available, but a correlation of the PACVD parameters with some of the key coating properties is required. Thus, a predictive capability that is lacking in the present science base can be established together with important phenomenological aspects needed for efficient deposition of high quality protective coatings. As the mechanisms become better understood, use of remote sensors and A.I. may then be introduced. This paper reviews selected diagnostic techniques available for characterizing these nonequilibrium reactive plasmas and the coatings.

22132 **Laser probes and numerical modeling as process diagnostics in chemical vapor deposition.** Breiland, W.G. (Sandia National Labs., Albuquerque, NM (USA)); Ho, P.; Coltrin, M.E.; Kee, R.J.; Evans, G.H. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

The chemical vapor deposition process consists of a chemically-reacting flow in which the fluid mechanics and chemical kinetics are strongly coupled. Laser probes such as Raman spectroscopy and laser-induced fluorescence can be used to measure gas temperature fields and chemical species concentrations, but often the interpretation of such data is difficult because several interacting chemical and physical phenomena are occurring simultaneously. Detailed numerical modeling of the experimental system under study provides valuable insights into these interactions and allows one to make useful comparisons between experiment and the model to gain a fundamental understanding of the CVD process. Examples of this approach are given for silicon deposition from silane and fluid mechanics diagnostics in a rotating disk CVD reactor.

22133 **Weldability and microstructural analysis of nuclear-grade austenitic stainless steels.** Lee, C.H. Thesis (Ph. D.). 465p. Univ. of Tennessee, Knoxville, TN (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-11,734.

This study evaluated the hot-ductility response, and hot-cracking susceptibility (fusion-zone solidification cracking and HAZ liquation cracking) of modified nuclear-grade and standard austenitic stainless steels. Extensive microstructural characterization using state-of-the-art analytical electron microscopy (TEM and STEM) as well as SEM (EDAX) and OLM was performed to correlate the material behavior with metallurgical characteristics. In addition, studies of the effect of Si, N, and rare earth elements on hot-cracking susceptibility, significance of the ductility dip phenomena and backfilled solidification cracks were also performed. Furthermore, based on the metallurgical evaluation, the possible mechanisms involved in solidification cracking and HAZ liquation cracking of the modified alloys are proposed. Finally, the optimized chemical specifications and requirements for nuclear-grade stainless steels are also suggested.

22134 **Anomalous behavior of the electrical resistivity in alloys near the $PrNi_{5.0}$ composition.** Cho, W.D. (Ames Lab., IA (USA)); Gschneidner, K.A. Jr. *Journal of the Less-Common Metals*

(Switzerland), 156(1/2): 87-96 (Dec 1989). DOE Contract W-7405-ENG-82.

The phase relationships near the $PrNi_5$ composition at high temperatures (above 1000deg C) were determined. At 1000deg C a solid solution region, about 1 at.% wide, exists from $PrNi_{5.0}$ to $PrNi_{5.2}$. The electrical resistivity was measured for six alloys with compositions between $PrNi_{4.6}$ and $PrNi_{5.2}$ from room temperature to 4.2 K. Thermal cycling of the alloy leads to a resistance increase of 10%-20% over the initial room temperature value. Metallographic studies confirmed that this increase was due to crack formation upon cooling. The results obtained in this study suggest that $PrNi_{4.8}$ and $PrNi_{4.9}$ would be the best compositions of the six samples studied for use as a nuclear refrigerant to reach millikelvin temperatures. (orig.).

22135 Alloying of metals for corrosion resistance. McCafferty, E.; Hubler, G.K.; Natishan, P.M. To Department of the Navy, Washington, DC. USA Patent Application 7-414,223. 29 Sep 1989. 19p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The corrosion resistance of bulk metals is improved by implanting a corrosion-resistant species into the surface of the bulk metal in a layer beginning at the surface and extending to a depth of at least about 50 angstroms. An amount of corrosion-resistant species is deposited so that the oxide layer that forms on the corrosion-resistant species implanted bulk metal is composed of at least about three percent of the oxide of the corrosion-resistant species.

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Refer also to citation(s) 21133, 21169, 21449, 21451, 21959, 22033, 22068, 22069, 22094, 22099, 22121, 22126, 22170, 22241, 22282, 22870, 22972, 22974

22136 (AD-A-214646/2/XAB) **Studies of the structure and properties of amorphous a-Ar76Fe24Hx.** Bowman, R.C.; Maeland, A.J.; Unruh, K.M.; Venturini, E.L.; Rush, J.J. Aerospace Corp., El Segundo, CA (USA). Laboratory Operations. 31 May 1989. 12p. (TR–0088(3057)-2). Available from NTIS, PC A03/MF A01.

The a-Zr76Fe24Hx samples with x < or = 173 have been shown to remain amorphous after reaction of the glassy alloy with gaseous hydrogen. Magnetic susceptibility and Mossbauer spectroscopy indicate that the electronic structure of the alloy is modified upon hydrogen absorption. Proton spin-lattice relaxation times suggest a strong hyperfine interaction with the iron d-states. The vibrational spectrum of a-Zr7+Fe24H173 from inelastic neutron scattering shows hydrogen occupancy in a distribution of tetrahedral interstitial sites. Calorimetry and x-ray diffraction demonstrate that a Zr76Fe24H(x) with x > 140 irreversibly crystallizes into c-Zr(Hx) and $ZrFe_2$.

22137 (BNL–43772) **The role of polarity on the stability of graphitic compounds.** Wentzcovitch, R.M. (State Univ. of New York, Stony Brook, NY (USA). Dept. of Physics); Continenza, A.; Freeman, A.J. Brookhaven National Lab., Upton, NY (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8911168–1: Materials Research Society meeting on diamond, boron nitride, silicon carbide and related wide bandgap semiconductors, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90006528. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

There is an old puzzle associated with the series of compounds formed by first row elements, C, BN, and BeO: similar to the other members of the family of octet semiconductors, these compounds exist in dense phases like diamond and zincblende, or hexagonal diamond (lonsdaleite) and wurtzite; however, whereas C and BN also exist in low density graphitic phases, BeO does not. Until now it has not been understood if the absence of BeO in this latter series is caused by simple technical difficulties in preparing the compound or by an intrinsic structural instability of the graphitic phase with respect to the dense wurtzite phase. There is some interest in layered BeO because of its expected exotic intercalation chemistry, as well as some possible unusual properties in this highly polar 2-D oxide. In this report, the stability of graphitic BeO is discussed based on all-electron full-potential linearized augmented plane wave method. 11 refs., 3 figs.

22138 (CONF-891119–108) **Direct imaging of the atomic structure and chemistry of defects and interfaces by Z-contrast STEM [scanning transmission electron microscopy].** Pennycook, S.J.; Chisholm, M.F.; Jesson, D.E.; Norton, D.P.; McCamy, J.W.; Lowndes, D.H. Oak Ridge National Lab., TN (USA). Feb 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90008488. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Z-contrast scanning transmission electron microscopy (STEM) is a fundamentally new approach to high-resolution imaging which provides unambiguous, compositionally sensitive images on the atomic scale. Such images are intuitively interpretable, even in thick regions of the sample, tremendously simplifying determination of the structure and chemistry of defects and interfaces. To illustrate this, examples are presented of commonly observed planar defects in laser-ablated thin films of $YBa_2Cu_3O_{7-x}$. Film/substrate interfaces are shown to be chemically diffuse on the atomic scale and steps or undulations in the substrate need not result in defects in the film. Low-angle grain boundaries are found to be chemically clean, the drastic reductions in critical currents with tilt angle being due to the array of intrinsic structural defects comprising the boundary. 20 refs., 10 figs.

22139 (CONF-900206–2) **Toughened $YBa_2Cu_3O_x/ZrO_2$ composites.** Goretta, K.C.; Kullberg, M.; Baer, D.; Dorris, S.E.; Balachandran, U.; Poeppel, R.B.; Routbort, J.L. Argonne National Lab., IL (USA). Jan 1990. 12p. Sponsored by American Nuclear Society; U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990. Order Number DE90007796. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tetragonal ZrO_2 particles have been added to $YBa_2Cu_3O_x$ to improve the fracture toughness of the superconductor. For some processing procedures, toughness was increased from 1 to 3 $MPa(m)^{0.5}$, but in some cases ZrO_2 reacted with $YBa_2Cu_3O_x$ and destroyed its superconductivity. Coating the ZrO_2 with Y_2BaCuO_5 is being explored to minimize the reaction between ZrO_2 and $YBa_2Cu_3O_x$. 25 refs., 5 figs.

22140 (CONF-900206–3) **Deformation processing of $YBa_2Cu_3O_x$.** Goretta, K.C., McGuire, M.J.; Brandstaedter, A.; Singh, J.P.; Poeppel, R.B.; Schultz, A.J.; Routbort, J.L. Argonne National Lab., IL (USA). Jan 1990. 13p. Sponsored by American Nuclear Society; U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990. Order Number DE90007795. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Generalized plasticity of polycrystalline $YBa_2Cu_3O_x$ at high temperatures was achieved by diffusional flow; from 850 to 980°C, strain rates of approximately 10^{-4} s^{-1} were obtained without fracture. The strain rate for a given stress and temperature increased with decreasing oxygen partial pressure. Although dislocations are mobile at elevated temperature, they are limited almost exclusively to the basal planes and hence deformation from their motion does not contribute significantly to total strain. 30 refs., 8 figs.

22141 (CONF-900393–2) **Mechanical behavior of whisker reinforced ceramics.** Becher, P.F. (Oak Ridge National Lab., TN (USA)); Lin, H.T. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International forum on fine ceramics '90; Nagoya (Japan); 12-16 Mar 1990. Order Number DE90008758. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The interest in ceramics and ceramic composites has prompted research concerned with mechanisms to toughen them and to improve their elevated temperature mechanical performance. The beneficial effects of ceramic whiskers on fracture toughness are derived from the high strength of the reinforcing phases and from crack deflection at interfaces. As described earlier, bridging of a crack by these reinforcing phases increases the fracture toughness by the formation of a bridging zone behind the crack tip wherein the bridging ligaments impose a closure stress on the crack. Similar toughening effects due to crack bridging are observed in silicon nitride ceramics containing elongated grains and in ceramics containing plate-like grains or reinforcing phases. The question that remained is whether or not such reinforced ceramics would exhibit attractive mechanical properties at elevated temperatures. This paper will review results that indicate that whisker reinforcement, and similar reinforcing approaches, improves the mechanical performance of ceramics at elevated temperatures.

22142 (DOE/ER/45167–T1) **Tensile fracture toughness of ceramic materials: Effects of dynamic loading and elevated temperatures.** Suresh, S. (Brown Univ., Providence, RI (USA). Div. of Engineering); Duffy, J.; Yeshurun, Y.; Yang, K.; Nakamura, T. Brown Univ., Providence, RI (USA). Div. of Engineering. [1990]. 39p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG02-84ER45167. Contract DMR-8714665. Order Number DE90008329. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experimental methods are presented for the determination of fracture initiation toughness of ceramics and ceramic composites in pure tension under quasi-static and dynamic loading conditions over a range of temperature spanning 20°C to 1300°C. Circumferentially notched and cyclic fatigue pre-cracked rods of a variety of ceramic materials were subjected to quasi-state tensile fracture (Stress intensity factor loading rate, $\dot{K}_I \approx 0.1\ MPa\sqrt{m}\cdot s^{-1}$) in an electro-servohydraulic test machine and to dynamic tensile fracture ($\dot{K}_I \approx 10^6 MPa\sqrt{m}\cdot s^{-1}$) using a modified tensile Kolsky (split-Hopkinson) bar. Dynamic finite element analyses of the circumferentially notched cylindrical rod have been conducted to develop the optimum specimen dimensions and tests procedures for ambient and elevated temperature dynamic fracture initiation toughness measurement. Experiments conducted on Al_2O_3, Si_3N_4 and SiC, and an Al_2O_3–25 volume% SiC whisker composite at room temperature indicate that the dynamic to quasi-state fracture initiation toughness ratio K_{Id}/K_{Ic} is in the range of 1.1–1.4. Scanning electron microscopy observations show that failure above 1100°C usually evolves by the nucleation, growth and coalescence of cavities. The mechanisms of elevated temperature quasi-state and dynamic fracture in polycrystalline Al_2O_3 are examined and possible causes for the apparently higher dynamic fracture initiation resistance are discussed. The significance and limitations of the proposed experimental techniques are highlighted. 25 refs., 14 figs., 3 tabs.

22143 (DOE/ER/45249–T1) **An investigation of the mechanisms of solid state powder reaction in the combustion synthesis and sintering of high temperature materials: Progress report, May 27, 1986–August 15, 1989.** Munir, Z.A. California Univ., Davis, CA (USA). Div. of Materials Science and Engineering. Aug 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-86ER45249. Order Number DE90007880. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the progress made over the period of May 27, 1986 to August 15, 1989, on a DOE-supported research aimed at providing a fundamental understanding of combustion-synthesis related reactions. Accomplishments made over the stated period are given below under two categories: Completed Work and Work in Progress. Because reprints and preprints of Completed Work are attached to this report, only a brief description of each of the items is given below. For items listed under Work in Progress, a brief summary of the most important results is provided.

22144 (DOE/ER/45303–2) **[Interface science in deformation processing of ceramics]: Progress report, May 1, 1989–February 28, 1990.** Raj, R. Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering. 15 Dec 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER45303. Order Number DE90008424. Available from NTIS, PC A03/MF A01 - OSTI.

The two major themes of the current work are: (i) the study of the mechanical properties of interfaces in ceramic materials in terms of their structure and chemistry, and (ii) the development of techniques for studying the growth of multilayer thin films of ceramics by vapor phase techniques. The thin film approach is useful because interfacial reactions under controlled oxygen activities can be studies in one-dimensional multilayers that contain flat interfaces. State-of-the-art techniques such as high resolution electron microscopy and Rutherford Backscattering can be used to obtain definitive results for the chemistry and structure of interfaces, and these results can then be applied to understand the mechanical properties of complex ceramic materials at high temperatures.

22145 (DOE/ER/45396–1) **Radiation disorder and aperiodicity in irradiated ceramics: Progress report, 22 June 1989–31 December 1989.** Hobbs, L.W. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering. [1989]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER45396. Order Number DE90008253. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two lines of research have been pursued in the six months since the program funding began on 22 June 1989. These are (1) to provide computer graphic representation of the physical models of tetrahedral network glass structure that Dr. Carol Marians had developed during a previous DOE-funded program, to assign coordinates to the tetrahedron vertices, and to minimize the energies of these configurations in order to provide a relaxed set of coordinates which could be compared to diffraction data; and (2) to initiate ion implantation into pyrophosphates in order to investigate radiation-induced disorder of partial network structures.

22146 (FSC–8903, pp. 14-18) **Technological tendency for recent monolithic refractory.** Hongo, Yasuo (Nihon Tokushu Rozai Co., Ltd., Okayama, (Japan)). Fuel Society of Japan, Tokyo (Japan). 13 Apr 1989. (In Japanese). In *Proceedings of 85th Special Coke Meeting in 1988.* Order Number DE90710560. Available from NTIS (US Sales Only), PC A03/MF A01; NTIS (US Sales Only), PC A04/MF A01.

Castable and spraying refractries of monolithic refractory show stable production, and plastic and refractory mortals decrease production year by year. In order to improve the refractoriness and corrosion resistance, fireproof base material and alumina of higher grade were used and binder to set was changed to develop the higher class castable refractries. Alumina cement, superfine aerosol silica and dispersing agent are used for dense type castable refractries. The aerosol silica which is a byproduct at ferrosilicon manufacturing is powder of several micron or less and hydrates with cement, making castable refrectories more dense and stronger. The increase of strength enables the decrease of the cement amount to result the development of ultra low cement castables. Further, fibrous monolithic refractory containing ceramic fiber and ultra rapid setting cement have also been developed. 2 figs., 3 tabs.

22147 (Juel-Conf–77) **Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.** Bilateral seminars of the International Bureau, Kernforschungsanlage Juelich GmbH. Kaysser, W.A.; Weber-Bock, J. (eds.). Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. 539p. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

This volume contains 36 contributions with following subjects (selection): Densification of highly reactive aluminium titanate powders; influence of precursor history on carbon fiber characteristics; influence of water removal rate during calcination on the crystallization of ZrO2 from amorphous hydrous precipitates; tape casting of AlN; influence of processing on the properties of beta-SiC powders; corrosion of SiSiC by gases and basic slag at high temperature;

influence of sintering and thermomechanical treatment on microstructure and properties of W-Ni-Fe alloys; mechanical alloying for development of sintered steels with high hard phase content (NbC); early stages of mechanical alloying in Ni-Ti and Ni-Al powder mixtures; growth and microstructural development of melt-oxidation derived Al2O3/Al-base composites; fabrication of RSBN composites; synthesis of high density coridierite bodies; comparative studies on post-HIP and sinter-HIP treatments on transformation thoughened ceramics; sinter HIP of SiC; precipitation mixing of Si3N4 with bimetallic oxides; temperature dependence of the interfacial energies in Al2O3-liquid metal systems; synthesis and microstructural examination of Synroc B; solid state investigation of ceramic-metal bonding; thermophysical properties of MgAl2O4; preparation, sintering and thermal expansion of MgAl2O4; microstructural studies on alumina-zirconia and metallized alumina ceramics; electrodeposition of metals (e.g. Ti, Mo, In) and metal oxides from molten salts; electrochemical deposition of Ti from nonaqueous media (DMSO, DMF); lithium as anode material in power sources (passivation); reduction of chromium(VI) when solar selective black chromium is deposited; thermodynamic optimization of phase diagrams (computer calculations); optimization of Na-Tl phase diagram; phase relations in the Y-Si-Al-O-N system: Controlled manufacturing of alpha/beta-SIALON composites. (MM).

22148 (Juel-Conf–77, pp. 383-391) **Thermophysical properties of $MgAl_2O_4$.** Schulz, B. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung 1 - Teilinstitut Kernbrennstoffe); Haase, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The thermophysical properties of $MgAl_2O_4$ i.e. specific heat, thermal expansion and thermal conductivity were determined of samples of different origin and interpreted on the basis of knowledge of the binary system MgO - Al_2O_3 and mechanisms of heat transfer. (orig.).

22149 (Juel-Conf–77, pp. 393-405) **Preparation, sintering and thermal expansion of $MgAl_2O_4$.** Milosevski, M. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet); Bliznakovska, B. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

$MgAl_2O_4$ spinel was obtained by the method of coprecipitation. Sintering kinetics was studied during the initial and intermediate stage of the process. It was shown that the Mg^{2+} ions are the rate controlling species in the initial stage of $MgAl_2O_4$ sintering. Coefficient of thermal expansion could be presented by the following relation: $\alpha = 8{,}50x10^{-6} + 4{,}90x10^{-10}T + 1{,}11x10^{-12}T^2$. (orig.).

22150 (LBL–28263) **Synthesis of alumina-coated SIC whiskers for production of SIC whisker-reinforced alumina composite materials.** Kapolnek, D. Lawrence Berkeley Lab., CA (USA). Dec 1989. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007778. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Thick coatings of hydrated basic aluminum sulfate, an alumina precursor, were precipitated on the surfaces of SiC whiskers from an aqueous solution. These coatings were then thermally decomposed to obtain alumina coatings on the SiC whiskers. Both high aspect ratio as-received SiC whiskers and reduced aspect ratio whiskers were used as core particles in the coating process. SiC content in the composite powders was controlled by either varying the amount of SiC whiskers that were added to the original coating solution, or by using multiple coating steps in the original SiC core particles. Coated whiskers were characterized before and after calcination using Scanning Electron Microscopy and X-Ray Diffraction. Samples of these composite powders were hot-pressed at 1600°C and 35 MPA pressure to obtain dense SiC whiskers-reinforced alumina composite materials. Polished surfaces of these composites were observed using optical microscopy and SEM to qualitatively analyze whisker distribution in the matrix and residual porosity in the material. In all composites using reduced aspect ratio whiskers, whisker distribution was uniform throughout the material, and residual porosity was very low. Fracture surfaces of some materials were observed in SEM, showing that a limited amount of whisker pull-out had occurred. 31 refs., 17 figs., 2 tabs.

22151 (N–90-13636) **Presented at the 11th workshop on ceramic coatings for wear and thermal applications, Edmonton, Alberta, 16-17 October 1989.** Miller, R.A.; Brindley, W.J.; Bailey, M.M. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 9p. (NASA-TM–102408;E–5160;NAS–1.15:102408;CONF-8910369–: 11. Workshop on ceramic coatings for wear and thermal applications, Edmonton (Canada), 16 Oct 1989). Available from NTIS, PC A02/MF A01.

The present state of development of thin thermal barrier coatings for aircraft gas turbine engines and thick thermal barrier coatings for truck diesel engines is assessed. Although current thermal barrier coatings are flying in certain gas turbine engines, additional advances will be needed for future engines. Thick thermal barrier coatings for truck diesel engines have advanced to the point where they are being seriously considered for the next generation of engine. Since coatings for truck engines is a young field of inquiry, continued research and development efforts will be required to help bring this technology to commercialization.

22152 (N–90-13666) **Thermodynamic properties of some metal oxide-zirconia systems.** Jacobson, N.S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. 63p. (NASA-TM–102351;E–5060;NAS–1.15:102351). Available from NTIS, PC A04/MF A01.

Metal oxide-zirconia systems are a potential class of materials for use as structural materials at temperatures above 1900 K. These materials must have no destructive phase changes and low vapor pressures. Both alkaline earth oxide (MgO, CaO, SrO, and BaO)-zirconia and some rare earth oxide (Y2O3, Sc2O3, La2O3, CeO2, Sm2O3, Gd2O3, Yb2O3, Dy2O3, Ho2O3, and Er2O3)-zirconia system are examined. For each system, the phase diagram is discussed and the vapor pressure for each vapor species is calculated via a free energy minimization procedure. The available thermodynamic literature on each system is also surveyed. Some of the systems look promising for high temperature structural materials.

22153 (N–90-14362) **Density of intercalated graphite fibers.** Gaier, J.R.; Slabe, M.E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. 15p. (NASA-TM–102411;E–5167;NAS–1.15:102411). Available from NTIS, PC A03/MF A01.

The density of Amoco P-55, P-75, P-100, and P-120 pitch-based graphite fibers and their intercalation compounds with bromine, iodine monochloride, and copper (II) chloride have been measured using a density gradient column. The distribution of densities within a fiber type is found to be a sensitive indicator of the quality of the intercalation reaction. In all cases the density was found to increase, indicating that the mass added to the graphite is dominant over fiber expansion. Density increases are small (less than 10 percent) giving credence to a model of the intercalated graphite fibers which have regions which are intercalated and regions which are not.

22154 (N–90-14368) **Strength and toughness of monolithic and composite silicon nitrides.** Salem, J.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jan 1990. 20p. (NASA-TM–102423;E–5188;NAS–1.15:102423). Available from NTIS, PC A03/MF A01.

The strength and toughness of two composite and two monolithic silicon nitrides were measured from 25 to 1400 C. The monolithic and composite materials were made from similar starting powders. Both of the composite materials contained 30 vol percent silicon

carbide whiskers. All measurements were made by four point flexure in surrounding air and humidity. The composite and monolithic materials exhibited similar fast fracture properties as a function of temperature.

22155 (PB–90-121682/XAB) **Determination of impurities in fine ceramics by inductively coupled plasma atomic emission spectrometry.** Okano, T.; Fujimoto, K.; Matsumura, Y.; Harimaya, S. Kawasaki Steel Corp., Tokyo (Japan). c 1989. 7p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Included in Kawasaki Steel Giho, Vol. 21, No. 2, 59-64(1989).

ICP-AES (inductivity-complex plasma atomic emission spectrometry) was applied to the simultaneous determination of impurities in fine ceramics. Boron nitride and aluminum nitride were digested by acid pressure decomposition in Teflon vessels. Zirconium oxide was decomposed by fusion with the mixture of sodium carbonate and sodium borate. A micro-injection technique enables the measurement of the high-salt-containing solutions without clogging, and permits the use of a single calibration curve with background correction. The proposed method, whose lower limit of determination is as low as ppm concentrations, is useful for the quality control of raw materials and products.

22156 (PNL-SA–17162) **Molten salt corrosion of hot-pressed Si_3N_4/SiC-reinforced composites and effects of molten salt exposure on slow crack growth of hot-pressed Si_3N_4.** Henager, C.H. Jr.; Jones, R.H. Pacific Northwest Lab., Richland, WA (USA). 3 Nov 1989. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-8910120–9: 1. international ceramic science and technology congress, Anaheim, CA (USA), 31 Oct - 3 nov 1989). Order Number DE90008624. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Corrosion and slow crack growth of hot-pressed Si_3N_4- based ceramic materials were studied to arrive at an initial determination of the severity of Na_2SO_4 molten salt environments. Slow crack growth testing revealed that Na_2SO_4 molten salt exposure accelerated crack growth in hot-pressed Si_3N_4 compared to crack growth in air at 1300 C. The salt exposure was observed to reduce the time to failure of precracked specimens by factors of two or three. Measured crack velocity was observed to obey a power law, $V = AK^n$, with $n = 5.2 \pm 0.2$ and $A = 7.6 \times 10^{-10}$. Standard corrosion coupon tests were performed on specimens of Si_3N_4/SiC-reinforced composites and hot-pressed Si_3N_4 monolithic material. Weight change measurements were performed after eight-hour immersion exposures at 950, 975, and 1000 C to Na_2SO_4. Hot-pressed Si_3N_4 + 5% MgO and Si_3N_4/SiC whisker-reinforced material exhibited similar surface features after molten salt exposure. A Si_3N_4/SiC fiber-reinforced material, however, revealed complete dissolution of SiC chopped fiber reinforcements.

22157 (UCRL–100216) **Fabrication of superconducting cable by explosive compaction.** Nellis, W.J. Lawrence Livermore National Lab., CA (USA). Jan 1989. 3p. Sponsored by U.S. Department of Defense; U.S. DOE Conservation & Renewable Energy; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890112–1: International superconductivity application convention, San Francisco, CA (USA), 11-13 Jan 1989). Order Number DE90008365. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Shock compaction of powders has several features which indicate a high potential for the processing of practical superconductors. Because the process is so fast, say 100 kbar applied for a μsec, compressive energy deposition and heating is localized on particle boundaries. By using single-crystallite powder grains the method could be used to heat and bond grain boundaries, while leaving the interiors of grains at relatively low temperature with a stable structure. Potentially this dynamic method offers the opportunity to selectively process grain boundaries in high-T_c superconductors and to obtain the microstructure required for high-J_c. This process is also capable of producing high-density ceramic compacts. A major industrial advantage to shock processing is the capability to scale to large dimensions and shapes using explosives. Possible dimensions are much larger than achievable with static high-pressure processing. Thus, the explosive compaction of powders offers tremendous potential for high-T_c superconductive applications of bulk-processed materials, provided the appropriate process can be determined. 5 refs.

22158 (UCRL–102017) **Reactive sputtering of molybdenum.** Jankowski, A.F.; Schrawyer, L.R. Lawrence Livermore National Lab., CA (USA). Jan 1990. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900419–2: 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings, San Diego, CA (USA), 1-6 Apr 1990). Order Number DE90008307. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The composition and crystalline structure of molybdenum-oxide thin films is controlled through the process of reaction dc magnetron sputtering. A systematic variation in target power density results in a continuous transition in the appearance of molybdenum-oxide from a translucent glass to a metallic-like film. New molybdenum-oxide crystal structures and compositions are found using XRD, SAD, AES depth profiling and STEM. 15 refs., 9 figs., 1 tab.

22159 **Optical diagnostics for a high power, RF-inductively coupled plasma.** Nogar, N.S. (Los Alamos National Lab., NM (USA)); Keaton, G.L.; Anderson, J.E.; Trkula, M. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

The authors report emission spectroscopy and laser-induced fluorescence used to monitor the field and tail-flame regions of a Hull-design inductively coupled plasma. This plasma is used for a variety of syntheses including SiC, TiC, BN, AlN and diamond. Temporally- and spatially-resolved spectra of both pure Ar and Ar/gas mixtures have been studied as a function of RF power, pressure and flow rate. Preliminary data suggest that the system is far from local thermodynamic equilibrium.

22160 **Structure studies on Tl-Ca-Ba-Cu-O high-Tc superconductors. Effects of cation disorder and oxygen vacancies.** Morosin, B. (Sandia National Labs., Albuquerque, NM (USA)); Baughman, R.J.; Ginley, D.S.; Schirber, J.E.; Venturini, E.L. *Physica C: Superconductivity (Netherlands)*, 165(1): 115-124 (1 Jan 1990). DOE Contract AC04-76DP00789.

Detailed structure determinations for numerous crystals grown using a "pseudo-flux growth" technique from different initial metal oxide ratios suggest that cation solid solution occurs in a number of Tl-Ca-Ba-Cu-O high-Tc superconductors. Such cation disorder may be responsible for both the small differences in lattice parameters as well as the substantial variation in Tc's for the same structure type reported by various investigators. Oxygen vacancies may also lead to small displacement of adjacent cations. The effects of vacuum and oxygen annealing on the superconducting properties are explored. (orig.).

22161 **Powder neutron diffraction and magnetic susceptibility of $^{248}CmO_2$.** Morss, L.R. (Argonne National Lab., IL (USA)); Richardson, J.W. Jr.; Williams, C.W.; Lander, G.H.; Lawson, A.C.; Edelstein, N.M.; Shalimoff, G.V. *Journal of the Less-Common Metals (Switzerland)*, 156(1/2): 273-289 (Dec 1989). DOE Contract W-31-109-ENG-38;AC03-76SF00098.

We report the first neutron diffraction experiments on a sample of approximately 55 mg of CmO_2, using the rare isotope ^{248}Cm. Preparative techniques have assured that the sample is close to stoichiometry and X-ray patterns show only the expected f.c.c. lines. The neutron diffraction experiments confirm that the sample is nearly stoichiometric and rule out the possibility that the oxygen atoms form a superlattice to accommodate a mixture of Cm^{3+} and Cm^{4+} ions. Magnetic susceptibility measurements give a μ_{eff} value of $(3.36 \pm 0.06)\mu_B$ for the effective paramagnetic moment, consistent with many other determinations of this property in Cm(IV) compounds, which have been interpreted in the past as indicating substantial Cm^{3+} impurity. In view of the contradiction between bulk susceptibility on the one hand and thermogravimetric and diffraction results on the other hand, we suggest that a re-evaluation of the electronic ground states in the actinide dioxides may be needed. Some other contradictory experimental results are given. (orig.).

22162 **Thermal stability and phase studies of LiH + BeH_2 system.** Cantrell, J.S. (Miami Univ., Oxford, OH (USA). Dept. of Chemistry (USA)); Beiter, T.A.; Souers, P.C.; Barry, P. *Zeitschrift fuer Physikalische Chemie (Wiesbaden) (Germany, F.R.)*, 163(pt.1): 233-238 (1989). DOE Contract W-7405-ENG-48. (CONF-880969–: International symposium on metal-hydrogen systems, fundamentals and applications, Stuttgart (Germany, F.R.), 4-9 Sep 1988).

Phase studies [powder X-ray diffraction (XRD)] were made of isothermally annealed material using a wide angle rotating anode diffractometer. The primary compositions studied were 1:1 and 2:1 of LiH:BeH_2 where the 1:1 gave $LiBeH_3$ and the 2:1 gave Li_2BeH_4. The thermal stability studies were made up to 425deg C by annealing in carefully controlled atmosphere reactors. These samples are stable long enough to obtain data without evidence of reaction. The BeH_2 used was that prepared by Ethyl Corp. and is believed to be relatively unchanged. (orig.).

22163 **Influence of diesel engine combustion on the rupture strength of partially stabilized zirconia.** Brinkman, C.R. (Oak Ridge National Lab., TN (USA)); VonCook, K.; Foster, B.E.; Graves, R.L.; Kahl, W.K.; Liu, K.C.; Simpson, W.A. *American Ceramic Society Bulletin (USA)*, 68(8): 1440-1450 (Aug 1989). DOE Contract AC05-84OR21400.

This article is on a study conducted to determine whether long-term exposure of two types of partially stabilized zirconia (PSZ) to the combustion environment of diesel engines would generate a change in mechanical properties. The author explains why PSZ was chosen for the study and goes on to discuss some reservations about the use of PSZ in diesel engines.

3606 Other Materials

Refer also to citation(s) 21137, 21302, 21494, 21535, 21600, 21663, 21691, 21693, 21694, 21702, 21703, 21704, 21729, 21827, 21863, 22050, 22066, 22067, 22122, 22127, 22142, 22147, 22154, 22241, 22302, 22315, 22334, 22339, 22344, 22453, 22869, 22970

22164 (AD-A–214843/5/XAB) **Metal-matrix composite: Strengthening mechanisms. Annual report, October 1988-September 1989.** Arsenault, R.J. Maryland Univ., College Park, MD (USA). Metallurgical Materials Lab. Oct 1989. 156p. (MML–1989-1). Available from NTIS, PC A08/MF A01.

All of the existing strengthening mechanisms proposed to explain the increase in strength of discontinuous reinforcement composites are based on the assumption that the reinforcement does not perform. However, it appears that TiB2 deforms at high temperature within the NiA1 matrix. It was also observed that there is no apparent dislocation generation due to the difference in coefficient of thermal expansion between TiB2 and NiAl. A finite element investigation has demonstrated how and why the deformation is localized in discontinuous reinforced composites. The addition of discontinuous SiC to Al alloys can result in a five-fold increase in the yield stress, and this increase in strength is readily accounted for by changes in the matrix strength.

22165 (AD-A–214989/6/XAB) **Program to study the oxidation of carbon-carbon composites and coatings on these materials. Final report, 15 July 1986-13 July 1989.** Cullinan, J.; Schaeffer, J.; Gulbransen, E.A.; Meier, G.H.; Pettit, F.S. Pittsburgh Univ., PA (USA). Dept. of Materials Science and Engineering. 30 Sep 1989. 209p. Available from NTIS, PC A10/MF A02.

The oxidation of carbon-carbon composites and coatings on these composites in oxygen at temperatures between 300 to 1400 C was investigated. State-of-the art systems were characterized prior to the oxidation studies by using optical and scanning electron microscopy. It was determined that uncoated carbon-carbon composites cannot be used at temperatures above about 400 C for extended periods of time because of oxidation. Oxidation does occur at temperatures below 400 C but at very low rates. Boron has not been found to be an effective inhibitor for carbon-carbon oxidation. Water vapor increased the oxidation rate of these uncoated composites at temperatures below about 600 C. Oxidation products involving boron were removed from these composites at temperatures above 600 C when water vapor was present in the gas. Coatings were useful in protecting carbon-carbon composites from oxidation under isothermal test conditions, but these coatings failed under cyclic conditions. The factors leading to the failure of coatings on carbon-carbon composites are described.

22166 (BNL–43851) **Molecular organization and electrical properties of mixed Langmuir-Blodgett multilayer thin films of polypyrrole.** Cheung, J. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering); Rosner, R.B.; Rubner, M.F.; Yang, X.Q.; Chen, J.; Skotheim, T.A. Brookhaven National Lab., Upton, NY (USA). [1989]. 9p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract AC02-76CH00016. (CONF-8909307–1: NATO advanced research workshop on conjugated polymeric materials: opportunities in electronics, optoelectronics, and molecular electronics, Mons (Belgium), 3-8 Sep 1989). Order Number DE90007627. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The molecular organization of Langmuir-Blodgett multilayer thin films containing electrically conductive polypyrrole chains dispersed throughout insulating domains of surface active pyrrole molecules was examined by several thin film spectroscopic techniques. Reflection-absorption FTIR and NEXAFS spectroscopy have revealed that the 3-ODOP (3-octadecanoyl pyrrole) surface active pyrrole molecules are highly oriented within the film with their fully extended hydrocarbon chains tilted away from the surface normal with an unusually large tilt angle of about 55°. Evidence for preferred orientation of the polypyrrole chains was also found. The multilayer films were found to exhibit very large dielectric constants (>100) at low frequencies and enormous conductivity anisotropies. These unusual electrical properties can be directly attributed to the molecular organization of the film which consists of polypyrrole chains sandwiched between well ordered layers of 3-ODOP molecules. 7 refs., 3 figs.

22167 (BNL–43876) **Extended x-ray absorption fine structure analysis applied to composite materials.** Maruyama, B. (Naval Research Lab., Washington, DC (USA)); Everett, R.K.; Barrera, E.V.; Heald, S.M. Brookhaven National Lab., Upton, NY (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9005133–1: International conference on composite interfaces, Cleveland, OH (USA), 21-24 May 1990). Order Number DE90008575. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Extended X-ray Absorption Fine Structure (EXAFS) is a spectroscopic technique which allows the determination of the atomic structure of materials. EXAFS can be used to determine nearest neighbor identity, coordination number, interatomic distance and degree of disorder, and therefore is particularly useful for investigation of the atomistic structure of composite interfaces. Using EXAFS and related techniques, the structure of an interface can be investigated in a non- destructive manner. After a brief description of the EXAFS technique, its utility will be demonstrated through a study of vanadium barriers at aluminum-graphite interfaces. It is found that the vanadium reacts strongly, forming vanadium oxide and carbide, while little unreacted metallic vanadium remains. 10 refs., 6 figs.

22168 (CONF-891119–107) **Characterization of ceramic matrix composites fabricated by chemical vapor infiltration.** Stinton, D.P.; Hembree, D.M. Jr.; More, K.L.; Sheldon, B.W.; Besmann, T.M. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90008409. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A process for the preparation of fiber-reinforced SiC composites by chemical vapor deposition has been developed at Oak Ridge National Laboratory. Composites are prepared by infiltrating fibrous preforms with reactant gases that decompose at elevated temperatures to deposit silicon carbide between and around the fibers. Because the infiltration process utilizes both temperature and pressure gradients, SiC is deposited under conditions that vary considerably from the hot face to the cool face of the composite. Matrix characterization of composite samples by transmission electron microscopy and Raman spectroscopy are described. 11 refs., 8 figs.

22169 (CONF-900588–1) **Tribological properties of boric acid and boric acid forming surfaces: Part 1, Crystal chemistry and self-lubricating mechanism of boric acid.** Erdemir, A. Argonne National Lab., IL (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 45. annual meeting of the Society of Tribologists and Lubrication Engineers; Denver, CO (USA); 7-10 May 1990. Order Number DE90005665. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An in-depth understanding of the atomic-scale structure and chemistry of self-lubricating solids and how they relate to the efficiency and endurance of large-scale tribosystems is critically important. Of particular interest is the utilization of this understanding for the development of mechanistic models that can increase our ability to assess and predict the capabilities of self-lubricating solids. Accordingly, a comprehensive investigation was made of the crystal chemistry and self-lubrication mechanisms of boric acid and boric acid-forming surfaces. In this paper, the fundamentals of the crystal chemistry and the proposed lubrication mechanism of boric acid are described. Pin-on-disk tests performed on cold-pressed boric-acid pins and AISI 52100 steel disks, showed that the friction coefficient of this tribosystem is approximately 0.1. The results of this investigation indicate that boric acid, owing to its unique crystal structure and bond characteristics, is a promising solid lubricant for a wide range of tribological applications. 18 refs., 5 figs.

22170 (CONF-900588–2) **Tribological properties of boric acid and boric-acid-forming surfaces: Part 2, Formation and self-lubrication mechanisms of boric acid films on boron- and boric-oxide-containing surfaces.** Erdemir, A.; Fenske, G.R.; Erck, R.A.; Nichols, F.A.; Busch, D. Argonne National Lab., IL (USA). [1990]. 23p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 45. annual meeting of the Society of Tribologists and Lubrication Engineers; Denver, CO (USA); 7-10 May 1990. Order Number DE90005632. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the formation and self-lubricating mechanisms of boric acid films on boron- and boric oxide-containing surfaces. As reported in part I, boric acid, owing to a layered triclinic crystal structure and weak interlayer bonds, enjoys an unusual lubrication capability. RF-magnetron sputtering and vacuum evaporation techniques were used to produce thin coatings of boron and boric oxides on steel substrates. The results of tribological experiments indicate that the room temperature friction coefficient of tribosystems that include boron and/or boric oxide coatings ranges from 0.05 to 0.07, depending on the coating type. Laser-Raman spectroscopy of these surfaces revealed that this low friction is associated with a thin boric acid film that forms on the surfaces of these coatings. The fabrication and potential importance of boric acid and boric acid-forming surfaces for practical applications are enumerated. Surface engineering of tribomaterials, such as these demonstrated in this paper, is suggested as a new lubrication concept for use in present and future tribological industries. 16 refs.

22171 (DOE/ER/45259–8) **Band electronic structures and crystal packing forces: Progress report, January 1989–February 1990.** Whangbo, M.H. North Carolina State Univ., Raleigh, NC (USA). Dept. of Chemistry. 23 Feb 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER45259. Order Number DE90007669. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report briefly describes the highlights of our research progress made during the period of January, 1989-February, 1990. Our progress has been achieved in several areas of our research: organic conducting salts, high temperature copper-oxide superconductor, and low-dimensional oxides and chalcogenides exhibiting charge density wave phenomena.

22172 (DOE/ER/45362–2) **Stabilization of high T_c superconductivity in cadmium sulfide: Progress report, February 1989–February 1990.** Nettel, S.J.; MacCrone, R.K. Rensselaer Polytechnic Inst., Troy, NY (USA). [1990]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45362. Order Number DE90008249. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

For the past year and a half we have been addressing the problem of stabilizing the anomalous magnetic properties of pressure quenched, chlorine doped, cadmium sulfide. The essence of our proposal was to develop a fully reproducible procedure for obtaining magnetically active samples. Our experimental work to date has verified that the anomalous magnetism does exist. We have observed both large diamagnetism and large paramagnetism. In all cases the magnetization varies as a function of time. We have confirmed and obtained further evidence that a phase transition occurs in chlorine doped cadmium sulfide at the critical concentration of 0.75 wt % chlorine with x-ray diffraction. This evidence of instability is consistent with our observation of the difficulty of controlling the chlorine during the precipitation of cadmium sulfide near the critical chlorine concentration. All the experimental observations, in particular the slow variations in the anomalous magnetism, have influenced and support the theoretical approach we have been taking. Thus, we believe that our program is well established, and has had sufficient success to warrant our proposing its continuation through the third year. This would enable us to complete our systematic investigation and establish the procedures leading to superconductivity in cadmium sulfide, and possibly, in related materials. Establishment of high T_c superconductivity in a material as different from the original high T_c superconductors as is cadmium sulfide would obviously be of the greatest scientific importance. We feel that part of our success lies in having obtained significant insight into the nature of the difficulties with cadmium sulfide, and the features required for superconductivity, and the pathway by which these may be attained.

22173 (ECN–219) **Crystallographic and magnetic properties of $(C_6D_{11}ND_3)CuBr_3$ and $(Zn_{1-x}Mn_x)_3As_2$: A neutron scattering study.** Vries, G.C. de (Netherlands Energy Research Foundation, Petten (Netherlands)). Netherlands Energy Research Foundation, Petten (Netherlands); Technische Univ. Eindhoven (Netherlands). Aug 1989. 153p. Order Number DE90706033. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The investigations described concern the crystallographic and magnetic properties of the quasi one-dimensional (1d) ferromagnetic system $(C_6D_{11}ND_3)CuBr_3$ (or CHAB) and the II-V type diluted magnetic semiconductor $(Zn_{1-x}Mn_x)_3As_2$ (or ZMA). Both compounds have been studied with various neutron scattering techniques. The crystallographic properties of CHAB and ZMA have been investigated by neutron diffraction. These diffraction experiments were carried out at the High Flux Reactor (HFR) at Petten, Netherlands. For the investigation of the static and dynamic magnetic properties of CHAB neutron scattering experiments were performed in Petten as well as other European reactor institutes. These investigations comprise a study of the 3d long-rate order and the 1d correlations of the magnetic moments, and a study of the behaviour of the linear spin-wave excitations.

22174 (EJF–89-05944) **Porous transparent aerogels: Development of superinsulating window technology: Appendix 2.** Gesser, H.D.; Goswami, P.C. Faraci (E.J.) and Associates Ltd., Winnipeg, MB (Canada). Jul 1988. 88p. Contract EMR 23216-6-6257/01SZ. (MICROLOG–89-05944). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Aerogels are extremely porous, low-density materials, consisting of inorganic oxides such as silica, alumina, zirconia, stannic or tungsten oxide, or a mixture of these oxides. They have large surface areas and can be translucent as well as transparent, have extremely low thermal conductivities,and sound velocities as low as 100 m/s. This review surveys the literature up to the end of 1987 and summarizes the historical background of aerogel development, its production by the sol-gel process, possible drying methods, structural investigations, and various novel applications in radiation counters, super-insulating windows, solar concentrators, and as catalysts, for the gelation of rocket propellants, for the densification of carbon-carbon fibre composites, as insecticides, and for low-temperature glass formation. A widespread passive solar energy application of aerogels, primarily as super-insulation, would require cheaper methods of production, especially in relation to drying. An

alternative freeze-drying method that employs solvents with higher melting points has been developed in a laboratory. 209 refs., 13 figs., 11 tabs.

22175 (IEA-HPC-WR–2, pp. 81-102) **Soil property and external factor effects on soil thermal resistivity.** Salomone, L.A. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Sep 1987. (CONF-8610224–:). In *Proceedings of the workshop on ground-source heat pumps.* Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

Heat transfer from earth-contact surfaces, such as ground heat exchangers for heat pumps, is not well understood despite recent advances. One difficulty in estimating the heat transfer is uncertainty in the thermal resistivity of the soil. Because the soil's moisture content is strongly variable, its thermal resistivity is rarely constant. Moisture content is influenced by the groundwater level, precipitation, evaporation, vegetation, and temperature-induced moisture migration. When the water table is relatively high, the groundwater level directly determines the moisture content. If the water table is very low, evaporation and precipitation influence the ambient moisture content. In addition to these external factors, moisture content is affected by other physical properties of the soil including its water retaining capacity and hydraulic conductivity. Progress in determination of the thermal behavior of soils has been hampered because information on soil properties is scattered among various technical disciplines. Moreover, the professionals involved lack a common language to describe the thermal behavior of soils. Effective use of the earth as a heat source and/or sink for a systematic approach for selecting appropriate values of thermal resistivity. This paper examines the factors that affect the thermal behavior of soils. These factors include soil type, dry density, moisture content, water retaining capacity, temperature, and heat-flux density. An approach for considering these factors when establishing design values of thermal resistivity is presented along with recommended topics for future research. (orig.).

22176 (INIS-mf–11554) **Luminescence and energy transfer processes in rare earth compounds.** Vliet, J.P.M. van. Rijksuniversiteit Utrecht (Netherlands). 5 Jun 1989. 127p. Order Number DE90706046. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

In this thesis some studies are presented of the luminescence and energy transfer in compounds containing Eu^{3+}, Pr^{3+} and Gd^{3+} ions. Ch. 2 deals with the energy migration in the system Gd 1 – xEu x(IO 3) 3. In Ch. 3 the luminescence properties of the Pr^{3+} ion in the system La 1 – xPr xMgAl 1 10 19 are reported. Ch. 4 discusses the luminescence properties of alkali europium double tungstates and molybdates AEuW 20 8 and AEuMo 20 * (A^+ = alkali europium metal atom). The luminescence and energy migration characteristics of the isostructural system LiGd 1 – xEu xF 4 and Gd 1 – xEu xNbO 4 are reported in Ch. 5. In Ch. 6 the mechanism of energy migration in (La,Gd)A10 3 and (Gd,Eu)A1O 3 is discussed. Ch. 7 deals with the system Na 5(Gd,Eu) (WO 4) 4. In Ch. 8 the luminescence and energy transfer properties of two europium which has pseudotetragonal structure, and Eu 1 . 0 6TeO x, which has a monoclinic, ordered structure. 201 refs., 39 figs., 8 tabs.

22177 (N–90-13449, pp. 68-69) **Status of Gr/glass composites technology at UTOS.** Mayor, R.A. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1988. (NASA-CR–184656;JPL-PUBL–88-23;NAS–1.26:184656;CONF-8709487–: Asilomar 3LDR workshop, Asilomar, CA (USA), Sep 1987). In *Report of the Asilomar 3 LDR Workshop.* Available from NTIS, PC A08/MF A01.

The TSC (Thermally Stable Composite) refers to a family of graphite reinforced glass matrix composite materials developed by UTOS. This fiber matrix combination exhibits low coefficients of thermal expansion (CTE), exceptional dimensional stability, high specific strength and stiffness, adequate fracture toughness, and space environment compatibility. The dimensional stability of a TSC mirror structure was experimentally characterized at the Steward Observatory. Preliminary results indicate that TSC is significantly more thermally stable than most current structural composite materials. In addition, the use of lower CTE glass matrix materials, such as 96 percent silica glass, have the potential for producing graphite/glass panels with expansion rates and stability comparable to that of fused silica.

22178 (N–90-13449, pp. 72-73) **Advanced composite materials for precision segmented reflectors.** Stein, B.A.; Bowles, D.E. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1988. (NASA-CR–184656;JPL-PUBL–88-23;NAS–1.26:184656;CONF-8709487–: Asilomar 3LDR workshop, Asilomar, CA (USA), Sep 1987). In *Report of the Asilomar 3 LDR Workshop.* Available from NTIS, PC A08/MF A01.

The objective in the NASA Precision Segmented Reflector (PSR) project is to develop new composite material concepts for highly stable and durable reflectors with precision surfaces. The project focuses on alternate material concepts such as the development of new low coefficient of thermal expansion resins as matrices for graphite fiber reinforced composites, quartz fiber reinforced epoxies, and graphite reinforced glass. Low residual stress fabrication methods will be developed. When coupon specimens of these new material concepts have demonstrated the required surface accuracies and resistance to thermal distortion and microcracking, reflector panels will be fabricated and tested in simulated space environments. An important part of the program is the analytical modeling of environmental stability of these new composite materials concepts through constitutive equation development, modeling of microdamage in the composite matrix, and prediction of long term stability (including viscoelasticity). These analyses include both closed form and finite element solutions at the micro and macro levels.

22179 (N–90-13449, pp. 112-113) **SiO overcoating and polishing of CFRP telescope panels.** Woida, P.; Hoffmann, W.F. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1988. (NASA-CR–184656;JPL-PUBL–88-23;NAS–1.26:184656;CONF-8709487–: Asilomar 3LDR workshop, Asilomar, CA (USA), Sep 1987). In *Report of the Asilomar 3 LDR Workshop.* Available from NTIS, PC A08/MF A01.

Development of carbon fiber reinforces plastic (CFRP) panel overcoating and polishing is structured in two parts. The first part utilized a short series of experiments to determine the feasibility of overcoating and polishing CFRP panels, and the second part employes a systematic approach to optimize techniques learned. Questions which required answers in the initial investigation are summarized. Tests were performedin the Steward Observatory's 2.2 Meter Vacuum Coating Chamber and began with 3 cm square pieces of CFRP facesheet material. Next, a 10 cm square and one-inch-thick CFPR-Aluminum core panel was tested. Tests were then conducted on a 0.5-meter-square Dornier panel (QUAD 4) with CFRP facesheets on two-inch aluminum Flexcore. To complete the initial study, a previously characterized 0.5 m Dornier panel (QUAD 23) was coated and hand polished. The mirror's optical performance was not affected by the SiO coating.

22180 (N–90-13609) **Gravimetric measurements of materials outgassing applied to graphite-epoxy laminates.** Scialdone, J.J. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. Dec 1989. 27p. (NASA-TM–100753;REPT–90B00039;NAS–1.15:100753). Available from NTIS, PC A03/MF A01.

The outgassing rates of two graphite-epoxy laminates, American Cyanamide 985B-626 and HST-7B-112, were obtained using a gravimetric method. The rates as a function of time and temperature were derived from the measurements of their mass losses at temperatures varying from 25 to 150 C and for a time span of up to 400 hours in a vacuum. The data from those measurements were reduced to obtain the outgassing activation energies, the mass losses per unit mass or area, and the corresponding outgassing rates. The rates are expressed in closed-form equations and are directly usable for medling computations. The procedures to obtain these parameters are shown and may be used for the evaluation of other materials. The results of the tests show that the activation energies of the two materials are: 4630 cal/mole for the 985B-626 materials and 4791 cal/mole for the HST-7B-112 sample no. 10 Graphite Exoxy. The outgassing rates of these materials are in the 10E-5 g/sq cm/hr range and they decay according to a power of time of 0.60 at 25 C, indicating that the outgassing process is mainly a diffusion at that temperature. The normalized

mass losses versus time obtained from these tests were compared to the discrete results obtained from the ASTM-E595 tests. The comparison provides general indications on the effects of temperature and time in relation to the ASTM test values obtained at 125 C for a 24-hour test duration.

22181 (N–90-14108) **preparation of 110K (Bi, Pb)-Sr-Ca-Cu-O superconductor from glass precursor.** Bansal, N.P. Case Western Reserve Univ., Cleveland, OH (USA). Oct 1989. 14p. (NASA-CR–185162;E–5131;NAS–1.26:185162;CONF-891020–: Annual conference and exhibition of the Water Pollution Control Federation, San Francisco, CA (USA), 15-19 Oct 1989). Available from NTIS, PC A03/MF A01.

The Bi1.5Pb0.5Sr2Ca2Cu3O(x) glass, prepared by rapid quenching of the melt, showed T(sub g) of 383 C, crystallization temperature of approx. 446 C, melting temperature of approx. 855 C, and bulk density of 5.69 g/cu. cm. in air. The as-quenched glass was oxygen deficient. On heating in O2, it showed a slow, irreversible, and continuous weight gain starting at approx. 530 C. The influence of annealing conditions on the formation of various phases was investigated by XRD and electrical resistivity measurements. The 110K-T(sub c) phase did not form below 840 C. The amount of this phase increased with the sintering time at 840 C. A sample annealed at 840 C for 243 h in air and furnace cooled showed the highest T(sub c)(R=0) of 107.2K and transition width delta T(sub c)(10 to 90 percent) of approx. 2 K.

22182 (N–90-14287) **Oxidation effects on the mechanical properties of SiC fiber-reinforced reaction-bonded silicon nitride matrix composites.** Bhatt, R.T. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Nov 1989. 38p. (NASA-TM–102360;E–5074;NAS–1.15:102360;AVSCOM-TR–89-C-018). Available from NTIS, PC A03/MF A01.

The room temperature mechanical properties of SiC fiber reinforced reaction bonded silicon nitride composites were measured after 100 hrs exposure at temperatures to 1400 C in nitrogen and oxygen environments. The composites consisted of approx. 30 vol percent uniaxially aligned 142 micron diameter SiC fibers in a reaction bonded Si3N4 matrix. The results indicate that composites heat treated in a nitrogen environment at temperatures to 1400 C showed deformation and fracture behavior equivalent to that of the as-fabricated composites. Also, the composites heat treated in an oxidizing environment beyond 400 C yielded significantly lower tensile strength values. Specifically in the temperature range from 600 to 1000 C, composites retained approx. 40 percent of their as-fabricated strength, and those heat treated in the temperatures from 1200 to 1400 C retained 70 percent. Nonetheless, for all oxygen heat treatment conditions, composite specimens displayed strain capability beyond the matrix fracture stress; a typical behavior of a tough composite.

22183 (ND-R–1406(S)) **A review of irradiation induced creep in graphite under CAGR conditions.** Brocklehurst, J.E.; Kelly, B.T. UKAEA Springfields Nuclear Power Development Labs. (UK). Jun 1989. 96p. Order Number DE90619435. Available from NTIS (US Sales Only), PC A05/MF A01: OSTI; INIS.

Graphite irradiation induced creep data have been reviewed in detail and compared with the existing model used for stress calculations under Commercial Advanced Gas Cooled Reactor conditions. The relationship between creep and elastic modulus is well established and allows the creep behaviour of any graphite in any orientation to be predicted. The model predicts the initial build up of creep strain in different graphites extremely well. However, there are differences between prediction and experiment in creep at high doses; a creep test on a pre-irradiated specimen showed rather more creep ductility than predicted, whilst in experiments under a constant stress applied for the whole period of irradiation, the creep rates decreased to lower values than predicted. It is suggested that to obtain better estimates of brick stresses future irradiation experiments should aim to generate creep data under realistic variations in applied stress level, or rather creep strain history. (author).

22184 (SAND–89-0773) **CCST [Center for Compound Semiconductor Technology] Research Briefs: Volume 1, Number 1.** Lyo, S.K.; Jones, E.D. Sandia National Labs., Albuquerque, NM (USA). Jun 1989. 38p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90007782. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Center for Compound Semiconductor Technology (CCST) was formed within the Solid-State Sciences Directorate at Sandia National Laboratories in 1988, as the culmination of a long-term thrust into compound semiconductor research and technology that began about ten years ago. At that time, it was realized that electronic and optoelectronic devices based on compound semiconductors would be necessary for photonic applications, and that they could provide greater radiation hardness, higher speed, and higher operating temperatures than comparable silicon devices and circuits. It was also realized that a successful program would require the development and integration of materials growth and processing capability, solid-state physics research, and device engineering. The program at Sandia grew steadily from the purchase of the first Molecular beam Epitaxy (MBE) system in 1981, and the discovery of strained-layer superlattices in 1982, to the completion of the Compound Semiconductor Research Laboratory in 1989. To more formally organize this effort, Sandia established the CCST in 1988, aided by $10M of funding from DARPA. The CCST comprises most of the compound semiconductor research and development activities in the Solid-State Sciences Directorate. Ongoing programs are funded by the DOE Office of Military Applications, DOE Basic Energy Sciences, DOE Conservation and Renewable Energy, and the Department of Defense. 15 figs.

22185 (SAND–89-1930C) **SiO_x precipitation: Defect density correlation with the n^+ substrate resistivity.** Mednarch, J.W. Sandia National Labs., Albuquerque, NM (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900562–1: Meeting of the Electrochemical Society, Montreal (Canada), 6-11 May 1990). Order Number DE90005593. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The thermal budget of a CMOS process, which employs n/n^+ epitaxial silicon, can constrain the SiO_x precipitation necessary for bulk gettering sites. This makes the control of both the precipitation and its distribution difficult. Little or no precipitation will occur when heat treatments are inadequate or the n^+ substrate O_2 concentration [O] is too low. Likewise, uncontrolled precipitation can lead to warpage, slip and the formation of surface stacking faults. Bulk precipitation is some CMOS processes using n/n^+ epitaxial silicon may not be feasible, because of the smaller thermal budgets. However; many CMOS processes using n/n^+ epitaxial silicon rely on some form of gettering. Extrinsic and intrinsic gettering techniques as well as pre-processed gettered wafers can be employed with CMOS processes to develop the necessary internal SiO_x defects for effective gettering . An experimental strategy was designed to determine how the CMOS thermal budget interacts with the extrinsic gettering layers on n^+ substrates with different [O]. Models for the defect densities and denuded zones developed from the strategy are reported for the polysilicon [Poly] and polysilicon/nitride [PN] extrinsic gettering layers. An unexpected correlation between the defect density and the n^+ substrate resistivity with [O] also is discussed. 10 refs., 1 fig., 3 tabs.

22186 (SAND–89-2696C) **Identification of defects in SOI [silicon-on-insulator] wafers.** Kelly, M.J.; Guilinger, T.R.; Medernach, J.W.; Tsao, S.S.; Jones, D.T.; Stevenson, J.O. Sandia National Labs., Albuquerque, NM (USA). [1989]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900598–1: 4. international symposium on silicon-on-insulators technology and device, Montreal (Canada), 6-11 May 1990). Order Number DE90006020. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Defects and metal contamination in device areas of silicon integrated circuits (IC) can limit yield in IC fabrication. We describe an electrochemical method for identification of structural defects and metal contamination in low-doped n-type silicon (dopant concentration of about $10^{15}/cm^3$). Anodic etching in 5 wt % hydrofluoric acid produces crystallographic etch pits which correlate with both structural and impurity defects. Etch pit densities also correlate well with reported values of defect densities calculated from gate oxide

breakdown. We show that the method is particularly suited to defect delineation in thin-film silicon-on-insulator (SOI) wafers. The technique is superior to chemical decoration etches and to transmission electron microscopy for defect delineation in thin-film SOI wafers since it does not etch bulk silicon and it has a detection limit much lower than 10^4–10^5 defects/cm^2. We used the procedure to demonstrate how defect levels are strongly affected by the process parameters used to synthesize Zone Melt Recrystallization (ZMR) and Separation by IMplanted OXygen (SIMOX) wafers. 10 refs., 6 figs.

22187 (SAND–90-0077C) **The viscoelasticity of curing thermosets.** Adolf, D.; Martin, J.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005107–1: ANTEC '90: Society of Plastics Engineers meeting, Dallas, TX (USA), 7-11 May 1990). Order Number DE90006535. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As a crosslinking polymer cures, dramatic changes in molecular architecture occur. These structural changes in turn affect the viscoelastic behavior of the material. At a critical extent of reaction (the gel point), the polymer undergoes a transition from a viscous liquid to an elastic solid. We have monitored the evolution of structure and viscoelasticity in an epoxy encapsulant used at Sandia, the diglycidyl ether of Bisphenol A (BADGE) cured with diethanolamine (DEA). The structure evolves according to percolation theory, and the viscoelasticity evolves according to out dynamic scaling theory for branched polymers. 7 refs., 4 figs.

22188 (SERI/TR–234-3610) **Assessment of biobased materials.** Chum, H.L. (ed.). Solar Energy Research Inst., Golden, CO (USA). Dec 1989. 175p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000300. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Biobased materials are polymers derived from renewable resources by chemical or combined chemical and mechanical methods, or produced directly in biological processes. Combinations of renewable and conventional fossil-fuel-derived plastics are also biobased materials. This assessment reviews materials from renewable resources and their properties including major biopolymers produced by plants and selected animal sources. Examples discussed are wood, its polymeric components such as cellulose and lignin, related polymers such as chitin, other carbohydrate polymers such as starch, which when combined with plastics can impart environmental degradability to the resulting material. The conventional role of inexpensive wood flour as a filler is reviewed as well as the future research necessary to bring these materials into a higher value use as a reinforcing material for composites. Automotive, building, and packaging materials applications are considered. Bioproduction of materials is reviewed for selected polymers such as cellulose, other plant cell wall polymers, and proteins, with emphasis on silk and wool. These materials can be produced with specific properties such as biodegradability (e.g., polyhydroxybutyrate and valerate copolymers, polylactide polymers) or specific mechanical properties.

22189 (STUK-B-VALO–58) **Natural analogues of bitumen and bituminized radioactive waste.** Hellmuth, K.-H. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Jul 1989. 87p. Order Number DE90619432. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Occurrences of natural bitumen provide possibilities to identify and assess materials, processes, phenomena and conditions in nature which can serve as model cases valid also with respect to a final repository. Natural bitumens meet the basic requirements for use as natural analogues. In natural sites, processes of bitumen formation and degradation often work simultaneously. The major processes are thermal alteration, evaporation, reaction with water, biodegradation, oxidation, weathering and radiation degradation. Progress in analytical organic geochemistry made during recent years has enabled a deeper understanding of the structural and compositional effects of these processes on bitumen. This is necessary in natural analogue applications. The time scales involved in degradation processes, as observed in natural occurrences, exceed the time scales dictated by the half-lives of most important fission products in low and medium level waste by orders of magnitude. Only exposure to the weather at the surface leads to a more rapid destruction of bitumen. Trace metals in bitumen arenot released until the matrix is completely destroyed. Products of radiation degradation and weathering of bitumen are able, to a certain degree, to delay migration of the metal ions released. Impregnation with bitumen may effectively reduce the microbial decomposition of easily destructable organic waste components, as can be deduced on the basis of the excellent preservation of fossils observed in bitumen. The complexity of all the natural sites described requires extensive understanding of the origin and kind of organic material in bitumen, its maturation, migration, alteration and degradation and of the geological and tectonic evolution of the site. The latter is used for establishing the time scale.

22190 (STUK-B-VALO–59) **The long-term stability of natural bitumen: A case study at the bitumen-impregnated limestone deposit near Holzen/Lower Saxony, FRG.** Hellmuth, K.-H. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Sep 1989. 69p. Order Number DE90619433. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Natural bitumen can be an aid in the assessment of the long-term behaviour of technical bitumen. Natural occurrences of bitumen usually have the drawback that the original material before alteration or degradation began is not known. The present work applies an alternative approach: on the basis of the geology and stratigraphy at a site where bitumen samples have been taken, the existence of a gradient in the parameters of subaerial and microbial degradation processes may be assumed. Relative variation in properties, composition and structure (bitumen content, volatile fraction, elemental composition, chromatographic fractions, saturated hydrocarbons, trace metals, humic substances) at different locations within the deposit have been analysed. The bitumen impregnates a bed of porous Jurassic limestone which crops out at the surface and dips under sediments of various permeability. The quality of the bitumen is in compliance with standards for soft technical bitumen, although it can be characterized as highly biodegraded. It has probably not been affected much by degradation since the Quarternary or possibly even late Tertiary, however, as observable variations in composition and properties are only minor and seem to exhibit no clear relation to the present geological setting. Only near the present outcrop are there signs of increased oxidation. Exposure to weather at the surface leads to destruction of the bitumen within a very thin surface layer. Traces of humic substances probably originating from the decomposition of bitumen were found. Rate of bitumen degradation at outcrops seems to coincide with the rate of weathering and erosion of the host rock. It can be concluded from the results that the time scales necessary to achieve significant alteration of bitumen under the given conditions far exceed the time scales dictated by the half-lives of radionuclides in low- and medium-level radioactive waste.

22191 (UCRL–21268) **Deep level transient spectroscopy in resistive layers.** Hunt, C.E. (California Univ., Davis, CA (USA). Dept. of Electrical and Computer Engineering); Ng, Kim. Lawrence Livermore National Lab., CA (USA). Jun 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008349. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This work investigates the application of the Deep Level Transient Spectroscopy (DLTS) technique to resistive semiconductor thin films, such as Silicon-On-Insulator (SOI) and thin layer of GaAs formed on semi-insulating material. Schottky diodes made on these materials were used in this study. The effect of the series resistance inherent in these types of thin-film test structures on the interpretation of data obtained from the measurement apparatus is discussed. It is observed that inverted DLTS signals occur in these structures because of the high series resistance. It is shown that ignoring this effect can lead to erroneous values of the activation energy and the density of traps. 2 refs.

22192 (UCRL–102644) **Demonstration of temperature-insensitive harmonic generation in deuterated l-arginine phosphate.** Barker, C.E.; Eimerl, D.; Velsko, S. Lawrence Livermore National Lab., CA (USA). 13 Dec 1989. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE

Contract W-7405-ENG-48. (CONF-900530–3: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90006262. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The thermo-optic coefficients of deuterated 1-arginine phosphate indicate temperature-insensitive phase-matching directions for second-harmonic generation. We present direct measurements that partially agree with these predictions, and provide an explanation of the discrepancies between predicted and measured behavior. 3 refs., 1 tab.

22193 Synchrotron photoemission studies of surfaces and overlayers. Chiang, T.C. (Dept. of Physics and Materials Research Lab., Univ. of Illinois at Urbana-Champaign, Urbana, IL (US)). pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). DOE Contract AC02-76ER01198. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

High-resolution core-level photoemission spectroscopy allows the distinction of atoms in different layers and in inequivalent sites by their binding energy shifts. By comparison with model structures and reference samples, the number of atoms in each distinct chemical configuration can be determined. The chemical shifts induced by adsorption can be correlated with the electronegativity difference between the substrate and the adsorbate atoms. These observations provide a quantitative description of the interaction and reaction between adsorbates and surfaces, and important information about the atomic structure and the electronic properties can be deduced. Results from several representative systems including the adsorption of In, Ag, and Sn on Si(100) are discussed.

22194 Coating properties which enhance the vacuum surface flashover potential of insulators. Leiker, G.R. (Texas Tech Univ., Lubbock, TX (USA)); Hatfield, L.L.; Kristiansen, M.; Colmenares, C.; Hofer, W.W.; DiCapua. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report the flashover strengths in vacuum of several common insulators (Lexan, Lucite, polyethylene, Macor, quartz, and an alumina-filled epoxy) increased using a spark discharge treatment which produces a thin hydrocarbon/metal oxide coating on the samples. Several techniques have been used to analyze the properties of this coating including: electron spectroscopy for chemical analysis (ESCA), mass spectrometry, and secondary electron emission (SEE) measurements. Mass spectrometry data shows that the formation of the high-flashover strength coating is strongly dependent on the amount of water vapor in the chamber during treatment. ESCA data shows the coating itself to be hydrophobic, keeping water from diffusing to the surface from inside the sample. Efforts to reproduce this coating using an RF plasma discharge have, to this point, been unsuccessful. However, a sample tested using a homemade, pure tungsten spark plug has shown an increased flashover strength.

22195 High-speed photography of energetic materials and components with a copper vapor laser. Dosser, L.R. (Monsanto Research Corp., Miamisburg, OH (USA). Mound Facility (USA)); Reed, J.W.; Stark, M.A. pp. 322 of Process diagnostics: Materials, combustion, fusion. Materials Research Society, Pittsburgh, PA (1988). DOE Contract AC04-76DP00053. (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

The evaluation of the properties of energetic materials, such as burn rate and ignition energy, is of primary importance in understanding their reactions and the functioning of devices containing them. One method for recording such information is high-speed photography at rates of up to 20,000 images per second. When a copper vapor laser is synchronized with the camera, laser illumination images can be recorded that detail the performance of a material and/or component in a manner never before possible. The laser can also be used for ignition of the energetic material, thus eliminating the need for bridgewires or electric squibs that can interfere with photography. Details of such ignitions are readily observable, and the burn rate of a material can be determined directly from the film. There are indications that information useful for the modeling of pyrotechnic reactions will become available as well. Results from high-speed photography of several pyrotechnic materials and devices are presented.

22196 Electron emission from conductors subjected to intense, short-pulse electric fields. Scarpetti, R.D. (Lawrence Livermore National Lab., CA (USA)); Goerz, D.A.; Bowen, P.R.; Hodgin, R.L.; Wong, K.C.; Champney, P.D.A. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract W-7405-ENG-48. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors discuss their study of electron emission from metal electrodes subjected to electric fields ranging from 0.5 to 2.5 MV/cm for pulse durations of 3 to 10 ns. They used two high-voltage pulsers for these tests: a 500-to 700-kV,72-Ω pulser that generated a 3-ns gaussian pulse; and a 2-MV, 60-Ω pulser that generated a 10-ns flat-top pulse with a 1-ns risetime.The high voltage levels allowed emission studies using electrode spacings of several millimeters to several centimeters. Their studies emphasized bare and anodized aluminum surfaces having surface finishes that ranged from rolled stock to machined finishes of 2-400 μ in roughness. They also investigated polished stainless steel and brass. Emphasis was on first-shot performance with subsequent pulses applied to check for possible conditioning. The background pressure was typically 5 x 10^{-5} Torr.

22197 Repetitively pulsed vacuum insulator flashover. Ginn, J.W. (Sandia National Labs., Albuquerque, NM (USA)); Buttram, M.T. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report experiments performed to determine the flashover strength of various vacuum insulators under conditions of repetitive pulsing. The pulse duration was 30 ns. and the thickness of a typical insulator sample was 1.8 cm. Data were taken for 45^0 insulators from five different materials. An insulator was subjected to an extended series of pulses at a given repetition rate and field. If flashover was not detected, the field level was increased and the sequence repeated. At rates up to 50 pulses per second, there was no apparent dependence of flashover field on rate. In addition, some single shot data were taken, including various modifications of the geometries and surface textures of the insulators. Only two of the modifications increased the flashover strength significantly over that of a 45^0 sample: annealing some plastics (roughly a 35% increase) and extending the insulator to cover the surfaces of both electrodes (an increase of nearly a factor of two).

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22198 (AD-A–214573/8/XAB) **Flexibility of the zeolite RHO framework in-situ x-ray and neutron powder structural characterizations of divalent cation-exchanged zeolite RHO.** Corbin, D.R.; Abrams, L.; Jones, G.A.; Eddy, M.M.; Harrison, W.T. California Univ., Santa Barbara, CA (USA). Dept. of Chemistry. 1989. 58p. (CONTRIBK–4930). Available from NTIS, PC A04/MF A01.

Zeolite RHO has an unusual three-dimensional monolayer surface with a topology that gives equal access to either side of the surface. In the absence of supporting structural subunits, e.g.,

smaller cages or channels. RHO exhibits atypical framework flexibility with large displacive rearrangements. These have been investigated by in-situ X-ray powder diffraction studies of zeolite RHO exchanged with various divalent cations. The unit cell variation (e.g., Ca, H-RHO(400 C), a = 13.970(5)A; Sr-RHO(250 C), a = 14.045(1)A; Ba-RHO(200 C), a 14.184(2)A; Cd-RHO(350 C), a = 14.488(3)A; Na,Cs-RHO(25 C), a 15.031A) is a particularly sensitive function of cation and temperature. Rietveld analysis of neutron diffraction data was used to refine the structures of two samples, CaND4-RHO and Ca,D-RHO. Ca,D-RHO shows the largest reported deviation from Im3m symmetry (a = 13.9645(7)A) for a RHO structure. The calcium atom is located in the center of the double 8-ring, distorting the framework to generate a tetrahedral environment. The results confirm one of the largest displacive distortions observed for a molecular-sieve framework with a unit cell volume increase of 25% when the calcium ions of Ca,H-RHO are replaced with hydrogen ions to give H-RHO.

22199 (CEA-CONF–9633) **The gaz chromatographic isotope separation system for the jet active gas handling plant.** Botter, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Tistchenko, S.; Leger, D.; Hircq, B.; Gowman, J.; Laesser, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI). 1988. 7p. (CONF-880505–: 3. topical meeting on tritium technology in fission, fusion and isotopic applications, Toronto (Canada), 1-6 May 1988). Order Number DE90756453. Available from NTIS (US Sales Only), PC A02/MF A01.

Displacement Gas Chromatography will be used at JET to extract pure T_2 and D_2 from mixtures of H_2, HD, HT, D_2, DT and T_2. This method makes use of strong isotopic effects in the β-phase of the Pd-Q system. Designed for a daily throughput of $\approx$ 20 moles of isotope mixtures, the system will incorporate four individual separation columns, each containing - 5 l packing of palladium on a porous alumina substrate. The main parameters, operation sequences and design principles are discussed.

22200 (CEA-N–2610) **Determination of radium 226 and 228 in water.** Jeanmaire, L.; Willemot, J.M.; Verry, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire. 1989. 19p. (In French). Order Number DE90756427. Available from NTIS (US Sales Only), PC A03/MF A01.

Usally, only radium 226 is measured in water since determination of radium 228 is not easy at the natural levels. A technique has therefore been developed to measure, at the same time and at low radioactivity levels, two radionuclides most often associated in water and with similar toxicity. Computer data processing brings significant improvements though calculation can be manually done.

22201 (CEA-R–5493) **Determination of the plutonium contamination level in biological samples by liquid scintillation.** Willemot, J.M.; Verry, M.; Lataillade, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire. 1989. 16p. (In French). Order Number DE90756425. Available from NTIS (US Sales Only), PC A03/MF A01.

Usual radiochemical processes are unable to carry out without delay the very large number of analyses as required in plutonium toxicology studies. Liquid scintillation is the best method to quickly determine plutonium contamination levels in most various samples (bone, organs,...).

22202 (CEGB-RD-B–6188/R89) **An assessment of Raman spectroscopy to detect iodine deposited on thin oxide films formed on Type 316 stainless steel.** Allen, G.C.; Tyler, J.W. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Apr 1989. 19p. Order Number DE90619218. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Iodine-131 is one of the most important volatile fission product elements with respect to radiobiological impact, and the characterisation of its chemical state and distribution on reactor surfaces is required for reactor safety assessments. To this end, duplicate samples of Type 316 (17%Cr/12%Ni) stainless steel oxidised in Co_2/CH_3I gas mixtures and previously characterised using X-ray photoelectron spectroscopy have been examined using Raman spectroscopy. The aim is to improve our understanding of the way in which iodine is distributed throughout the oxide scale and to identify its chemical state. In this report we present Raman spectra recorded from a series of stainless steel specimens together with spectra recorded from a number of standard iodine compounds. It is demonstrated that the technique is well suited as a fingerprint method of species identification, can differentiate between the chemical state of iodine as iodide and iodate and can analyse thin oxide films (5-50 nm). Identification of iodine deposits in these oxide films at concentrations of $\leq$1 At% was not achieved however, there being insufficient iodine present to distinguish any peaks present from the background signal. It is concluded that local concentrations of iodine in oxide inclusions of different composition/morphology on the steel surface does not occur to any extent. (author).

22203 (DOE/ER/60445–4) **Identification of genotoxic components of the heavy ends of energy-related materials: Final report, May 1, 1986–April 30, 1989.** Lee, M.L. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry); Castle, R.N. Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry. Feb 1990. 70p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60445. Order Number DE90008373. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objective of this work was to develop capillary supercritical fluid chromatographic methods for the analysis of the high-molecular-weight components in high boiling, heavy and materials that are responsible for genotoxic activity. Since these compounds were largely unknown, 62 standard reference compounds were synthesized for comparison with actual high boiling coal-derived products. These compounds were comprised of two- and three-ring aromatic moieties coupled together with carbon, oxygen, sulfur, and nitrogen bridging groups. Mass spectral evidence indicated that a number of these compound types could be present in various coal products at a concentration level of 0.01–0.2 percent, although none of them could be positively identified because of the complexities of the fractions. A number of capillary supercritical fluid chromatographic instrumental developments were made as a result of this work. These include a supercritical fluid fractionation system for group-type separation of complex samples and a direct coupled supercritical fluid chromatograph/double focusing mass spectrometer system. Finally, a number of supercritical fluid chromatographic mobile phase combinations were evaluated for the analysis of large polycyclic aromatic compounds. 34 refs., 23 figs., 2 tabs.

22204 (DOE-RW–89.001) **Actinide speciation, further development and application of laser induced photoacoustic spectroscopy and voltammetry.** Cross, J.E. (UKAEA Harwell Lab. (UK). Chemistry Div.); Crossley, D.; Edwards, J.W.; Ewart, F.T.; Liezers, M.; McMillan, J.W.; Pollard, P.M.; Turner, S. Department of the Environment, London (UK). Dec 1988. 73p. Contract PECD-7/9/312. (AERE-R–13299). Order Number DE90619236. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Further work is reported on the sensitive determination of actinide species in solution using the Harwell laser induced photoacoustic spectrometer (LIPAS). To permit speciation and solubility measurements under well controlled pH and Eh conditions a combined LIPAS/electrochemical loop has been developed and is described in detail. The new equipment has been used to study uranium and neptunium species at several pH's and Eh's between +280 and -400mV. Comparison of observed species with those predicted by the thermodynamic geochemical modelling code PHREEQE has revealed differences. These, in part, can be reconciled by database refinement, but, in part, have revealed deficiencies in knowledge that require further study. The sensitivity of LIPAS for the measurement of U, Pu, Np and Am species has proved to be high, up to ca 10^{-9}M, sensitivities generally being higher for alkaline solution conditions. Preliminary work indicates that LIPAS can be used to distinguish between Pu(IV) complexes with possible cellulose degradation products, typified by gluconic acid, and other organic acids likely to be present in a waste repository. (author).

22205 (KURRI-TR–318, pp. 87-90) **Rapid chemical separation of fission products by ion-chromatography.** Laksmi Andri Astuti (Radioisotope Production Center, Puspiptek (Indonesia)); Nishikawa, S.; Tamai, T.; Shibata, M.; Miyachi, M.; Yamamoto, H.;

Kawade, K.; Katoh, T. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. URANIUM 235/fission products; FISSION PRODUCTS/separation processes; ION EXCHANGE CHROMATOGRAPHY; QUANTITY RATIO; PH VALUE

22206 (PB–90-857046/XAB) **Sol-gel processes and materials. November 1971-October 1989 (Citations from the US Patent data base). Report for November 1971-October 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 60p. Available from NTISPC N01/MF N01.

Supersedes PB–89-870109.

This bibliography contains citations of selected patents concerning sol-gel processes and sol-gel derived materials and products. Selected patents include sol-gel compositions, ceramic and refractory materials, fabrication of silica glass, sol-gel thin films and coatings, transparent inorganic oxide glass, luminescent quartz glass, catalysts and catalyst supports, nuclear fuels preparation, abrasives for grinding wheels, sol-gel production of microspheres, alumina composites, photographic materials, and dental materials. (This updated bibliography contains 120 citations, 12 of which are new entries to the previous edition.)

22207 (PNL–6100-Pt.4, pp. 5-8) **Characterization of nitrosated coal liquid at 800 to 850°F.** Wright, C.W.; Chess, E.K. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The purpose of this study was to chemically characterize a complex, high-boiling coal-derived mixture that was assayed in several biological regimes to determine the fate of the amino-substituted polycyclic aromatic hydrocarbons (amino-PAHs) and the integrity of other chemical classes upon nitrosation. General results from the nitrosation of the standard mixtures indicated that none of the standards were affected by the chemical reaction conditions with the exception of the amino-PAHs and some easily oxidized compounds. In the present study, the 800 to 850°F distillate from the solvent-refined coal (SRC)-II process was fractionated, by adsorption column chromatography using neutral alumina, into chemical class fractions of aliphatic hydrocarbons (AHs), PAHs, nitrogen containing polycyclic aromatic compounds (NPACs), and hydroxy-PAHs. Half of the NPAC fraction was nitrosated at room temperature using $NaNO_2$ and HCl followed by hydrolysis and solvent extraction. Fractions and subfractions were analyzed by high-resolution gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS), and low-voltage probe-inlet mass spectrometry (LVMS). Analyses of the hydroxy-PAH fraction and tertiary amine (azaarenes) subfraction showed no detectable differences in the compounds present after nitrosation compared to the non-nitrosated fractions.

22208 (PNL–6100-Pt.4, pp. 9-10) **Supercritical fluid chromatography and mass spectrometry development for fossil fuels.** Smith, R.D.; Wright, B.W.; Udseth, H.R. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The purpose of this program is to develop and apply new supercritical fluid techniques for extraction, separation, and analysis of high molecular weight compounds and polar compounds for synfuel plants. Chromatographic methods combined with mass spectrometry compose a nearly ideal analytical approach for characterizing complex mixtures. The advantages of supercritical fluid chromatography (SFC) accrue from the nature of supercritical fluids. The solvating properties of supercritical fluid mobile phases approach those of liquid phases, yet solute diffusivity typically remains one to two orders of magnitude higher. These properties allow high separation efficiencies to be realized while exploiting the variable and often high solvating power of the supercritical fluid. Recent work has demonstrated that the performance of the supercritical fluid chromatography-mass spectrometer (SFC-MS) interface depends largely on the fluid expansion step. Detailed studies of the expansion of fluids through capillary restrictors identified several mechanisms whereby nonvolatile analytes could be lost, thus precluding their analysis. As a result, a revolutionary mass spectrometer ion source and interface was designed to address the various loss mechanisms. The new SFC-MS interface incorporates a mechanically pumped expansion region behind the chemical ionization source repeller electrode. Splitless injection been made possible for the first time allowing quantitation over a wide range of analyte concentration. The effects of sample flow rate, restrictor geometry, and effluent heating were briefly studied in relation to the transfer and detection of less-volatile and nonvoltaile analytes, and a significant improvement was noted for the new interface over previous design.

22209 Determination of plutonium oxidation states by solvent extraction. Schramke, J.A. (Pacific Northwest Lab., Richland, WA (USA)); Rai, D.; Fulton, R.W. pp. 31 of Geochemistry. Third Chemical Congress of North America. American Chemical Society, Washington, DC (US) (1988). DOE Contract AC06-76RL01830. (CONF-8806308–: Symposium on nuclear analytical chemistry and geochemistry, Toronto (Canada), 5-10 Jun 1988).

Several solvent extraction techniques for determining oxidation states of actinides in solution are available, but these techniques are accurate only if oxidation states remain constant during extraction. The reliability of these techniques for determining Pu oxidation states was tested with solutions that contained Pu concentrations sufficient for spectrophotometric analysis. Oxidation states were accurately determined in solutions that contained Pu(IV) or Pu(V), or in Pu(VI) solutions with 10^{-3} M $KMnO_4$ added as a holding oxidant. However, during solvent extraction of Pu(VI) solutions that did not contain a holding oxidant, significant conversion of Pu(V) to Pu(VI) occurred. Therefore, these techniques cannot be used to reliably differentiate between Pu(V) and Pu(VI) in solution. Another solvent-extraction procedure designed to determine reduced (Pu(III)+Pu(IV)) and oxidized (Pu(V)+Pu(VI)) Pu concentrations in dilute solutions in brines (< 6 M ionic strength Na and Mg brines) was tested and found to be reasonably reliable.

22210 Before NBL. Rodden, C.J. (New Brunswick Lab. (US)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 14-15 (Nov 1989).

A first-hand historical overview is given of some of the nuclear material measurements and measurement problems that were addressed prior to and at the beginning of the Manhattan Project.

22211 Measurements of plutonium. Larsen, R.P. (Argonne National Lab., IL (USA)). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 21-24 (Nov 1989).

Based on reviews of the early and recent literature concerning comparative measurements of plutonium, sources of measurement error are discussed. This paper focuses on those related to mass spectrometric isotope dilution.

22212 Analytical chemistry and measurement science: (What DOE has done for analytical chemistry). . Shults, W.D. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 40-46 (Nov 1989).

Over the past forty years, analytical scientists within the Department of Energy (DOE) complex have had impact on the field of analytical chemistry. This paper suggests six research/development areas that either originated within or were brought to maturity with the DOE laboratories. These areas have lead to new subdisciplines or to new ways of doing business.

22213 Neutron activation analysis and gamma ray spectrometry. Lyon, W.S. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.). *JNMM (Journal of Nuclear Materials Management) (USA),* 18(1): 66-70 (Nov 1989).

The authors present scientometric study of the citations and publication data. It shows the present state of neutron activation

analysis (NAA) and applied nuclear chemistry as compared to other analytical techniques.

22214 Mass spectrometry. Gramlich, J.W. (New Brunswick Lab., Argonne, IL (US)). *JNMM (Journal of Nuclear Materials Management) (USA)*, 18(1): 79-81 (Nov 1989).

The limiting factor to the absolute accuracy of isotopic measurements is no longer instrumentation hardware. This article discusses how greater understanding and control of the chemistry of sample purification, gravimetric blending of separated isotopes, filament loading, and the physico-chemical processes occurring at the high-temperature filament will be necessary before the advantages of robotic sample preparation and filament loading and automated analysis can be attained. Such improved understanding is seen to be an essential procursor to controlling and reducing the uncertainty in isotopic ratio measurements to one part in 10^5.

22215 Challenges of tomorrow... chemistry. Steindler, M.J. (Argonne National Lab., IL (USA)). *JNMM (Journal of Nuclear Materials Management) (USA)*, 18(1): 73-78 (Nov 1989).

According to the author, nuclear materials are going to play an increasing role in concerns regarding proliferation and international affair, with an increased demand for clean electric power, and in environmental and health and safety issues. Challenges range from detecting a single species in a sea of others at molar ratios of 10^{-12}, or smaller, to a knowledge of the fundamental physical chemistry (e.g., thermodynamics, activity coefficients. etc., of a two phase system, containing about 40 materials, at 500°C) for the lanthanide and actinide elements produced during reactor operation. Other concerns are identified and discussed.

22216 Direct dating of Phanerozoic sediments by the ^{238}U-^{206}Pb method. Smith, P.E. (Toronto Univ., ON (Canada). Dept. of Physics); Farquhar, R.M. *Nature (London) (UK)*, 341(6242): 518-521 (12 Oct 1989).

Direct radiometric age determination of Phanerozoic carbonates has been a long-standing problem in geochronology. Rb-Sr and K-Ar dating schemes, commonly used to constrain the chronology of Phanerozoic sediments, have so far proved to be unsuccessful in dating these rocks because of their poor enrichment in radiogenic ^{87}Sr and ^{40}Ar and also because of analytical difficulties. Recent studies have demonstrated that large amounts of radiogenic Pb exist in some carbonates and that they could be dated by the Pb-Pb method. However, the precision of this method is severely limited to samples having very high uranium to lead ratios because by the beginning of the Phanerozoic (≈590 Myr ago) 98% of ^{235}U originally present in the Earth had decayed to ^{207}Pb. Here we report the first isochron age of carbonates using the ^{238}U-^{206}Pb method on corals, This method, which gives good accuracy even for low U concentrations, has great potential for the direct dating of sedimentary sequences and should be valuable for refining the Phanerozoic timescale. (author).

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Refer also to citation(s) 21126, 21140, 21374, 21417, 21441, 21449, 22090, 22169, 22188, 22235, 22959

22217 (AD-A-214891/4/XAB) **Deuterium isotope effects during HMX combustion: Chemical kinetic burn-rate control mechanism verified.** Shackelford, S.A.; Goshgarian, B.B.; Chapman, R.D.; Askins, R.E.; Flanigan, D.A. Frank J. Seiler Research Lab., United States Air Force Academy, CO (USA). 1989. 12p. (FJSRL-JR-89-0014). Available from NTIS, PC A03/MF A01.

Pub. in Propellants, Explosives, Pyrotechnics, Vol. 14, 93-102(1989).

The appearance of a significant deuterium isotope effect during the combustion of the solid HMX compound verifies that the chemical reaction kinetics is a major contributor in determining the experimentally observed or global burn rate. Burn rate comparison of HMX and its deuterium labeled HMX-d(8) analogue reveals a primary kinetic deuterium isotope effect (1 deg. KDIE) at 500 psig (3.55 MPa) and 1000 psig (6.99 MPa) pressure and selectively identifies covalent carbon-hydrogen bond rupture as the mechanistic step which ultimately controls the further HMX burn rate under the static combustion conditions of this experiment. The 1 deg. KDIE value further suggests the rate-limiting C-H bond rupture occurs during the solid state HMX decomposition/deflagration portion of the overall combustion event and is supported by other independently published studies. A possible anomalous KDIE result at 1500 psig (10.4 MPa) is addressed. This condensed phase KDIE approach illustrates a direct link between lower temperature/pressure thermal decomposition and deflagration processes and their potential applicability to the combustion regime. Most importantly, a new general method is demonstrated for mechanistic combustion investigations which selectively permits an in-situ identification of the compound's burn rate-controlling step.

22218 (CEA-CONF-9659) **Chemiluminescence in the Ba(6s6p, $^1P_1$) + CO_2 and O_2 reactions.** Cuvellier, J.; Visticot, J.P.; Meynadier, P.; Binet, A.; Mestdagh, J.M.; Berlande, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). Jun 1988. 2p. (In French). (CONF-8806459-: 21. national colloquium on physics of atom and electron collisions, Caen (France), 21-24 Jun 1988). Order Number DE90756351. Available from NTIS (US Sales Only), PC A02/MF A01.

Published in summary form only. ELECTRON-ATOM COLLISIONS/chemiluminescence; ELECTRON-ATOM COLLISIONS/barium; CHEMILUMINESCENCE; BARIUM; EXCITED STATES; LASER RADIATION; CHEMICAL REACTION KINETICS; EMISSION SPECTRA; ENERGY SPECTRA; ENERGY-LEVEL DENSITY; ELECTRON BEAMS; BARIUM OXIDES

22219 (CRN-CPR-87-03) **Photophysics of internal twisting.** Heisel, F. (Strasbourg-1 Univ., 67 (FR). Centre de Recherches Nucleaires); Miehe, J.A.; Lippert, E.; Rettig, W.; Bonacic-Koutecky, V. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1987. 173p. Order Number DE90756401. Available from NTIS (US Sales Only), PC A08/MF A01.

The formation and characteristics of the "twisted intermolecular charge transfer" is studied. Basic concepts on dual fluorescence, steady-state fluorescence, kinetic investigations and cage effects are discussed. The theoretical treatment on the electronic structure of the bonded π - donor - π acceptor pairs is outlined. The two-electron, two-orbital model, the ab initio CI models of simple double, charged and dative π - bonds as well as complex dative π - bonds and the origin of the dual fluorescence of 9.9'-Bianthryl are shown. Concerning the stochastic description of chemical reactions, Master equation, Markov, Birth-Death and Diffusion processes, Kramers-Moyal expansion, Langevin equation, Kramers' approach to steady-state rates of reaction and its extension to non-Markovian processes, and also unimolecular reactions in the absence of potential barrier are considered. Experimental results and interpretation on dynamics of DMABN in the excited state, kinetics of other dialkylanilines, extended donor-acceptor systems with anomalous fluorescence and donor-acceptor systems without anomalous fluorescence are given.

22220 (CRN-CPR-88-08) **Intramolecular charge-transfer fluorescence of a new class of sterically hindered bichromophoric molecules.** Eckert, C. (Strasbourg-1 Univ., 67 (FR). Centre de Recherches Nucleaires); Heisel, F.; Miehe, J.A.; Lapouyade, R.; Ducasse, L. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1988. 23p. Order Number DE90756412. Available from NTIS (US Sales Only), PC A03/MF A01.

We present an experimental study of the fluorescence properties of some diarylethylene derivatives whose excited states have charge transfer character and whose emission spectra are strongly solvent dependent. Time resolved experiments performed in propanol solutions at low temperature make evident that the total emission decays are strongly non exponential indicating the existence of an intramolecular reaction, with a time dependent rate, from the initial perpendicular configuration to the nearly planar one. The time resolved spectra show that an important spectral relaxation takes place with two characteristic times depending on the temperature.

22221 (DOE/ER/13570-4) **Metal alkoxides: Models for metal oxides: Alkoxide ligands in early transition metal organometallic chemistry: Progress report.** Indiana Univ.,

Bloomington, IN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13570. Order Number DE90007523. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The two most important results during the last year have come from studies of the activation of carbon monoxide by tetranuclear tungsten alkoxides and the activation of carbon-carbon double bonds in reactions with dinuclear tungsten alkoxides.

22222 (JAERI-M–89-176) **Development of lithium isotope separation process using crown compounds.** Fujine, Sachio (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Shimizu, Toku; Saito, Keiichiro; Shiba, Koreyuki. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 104p. (In Japanese). Order Number DE90759926. Available from NTIS (US Sales Only), PC A06/MF A01.

A new process of liquid chromatography is developed for lithium isotope separation using a crown compound. Crown compounds such as cryptand 221 and Benzo-15-Crown-5 have relatively high separation factors of 1.02≈1.05 for lithium isotopes $^6Li/^7Li$. Main subject of the present report is a search for an optimum chemical condition of multiplicating (cascading) the unit isotope separation effect. Displacement chromatography is successfully applied for the purpose. An automatically operable chromatography system was assembled and effective lithium isotope enrichment was performed using Cryptand 2_B21. The performance shows the feasibility of the new process for lithium isotope enrichment of engineering scale. A new solvent extraction process is also proposed and preliminarily studied for lithium isotope separation. (author).

22223 (LA-UR–90-485) **The calculation of hydrogen-bonding properties.** Ritchie, J.P.; Kober, E.M.; Faloona, I.C. Los Alamos National Lab., NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8911171–1: U.S. Army CRDEC scientific conference on chemical defense research, Aberdeen Proving Ground, MD (USA), 13-17 Nov 1989). Order Number DE90007534. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Hydrogen-bonding characteristics of molecules are extremely important in determining their boiling points, densities and water-solubilities, and these properties are important in understanding the adsorption of gases on charcoal. We show that empirical scales that measure hydrogen-bonding interactions can be correlated with the electrostatic properties of the molecules which agrees with previous worker's assessment that the hydrogen-bonding interaction is electrostatic in nature. Correlations both with single molecule properties as well as with the interaction energy between two molecules are found. This establishes a method for calculating these important properties which were previously available only through experiment or empirical scales. 12 refs., 3 figs.

22224 (LBL–28353) **The synthesis and reactivity of organoiridium complexes containing metal-heteroatom bonds.** Klein, D.P. Lawrence Berkeley Lab., CA (USA). Nov 1989. 145p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007762. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Irradiation of $Cp^*(PMe_3)IrH_2$(1) in tert-butylamine and tert-butanol gives exclusively the products of C-H, rather than N-H or O-H, insertion $Cp^*(PMe_3)Ir(CH_2CMe_2XH)H$ (2, X = NH; 3, X = 0). These oxidative addition products can be converted to the 2-aza- and 2-oxametallacyclobutane complexes by replacement of iridium-bound hydride by chloride using $CHCl_3$, followed by treatment with the hindered base $KN(TMS)_2$. The monomeric methylene complex $Cp^*(PMe_3)Ir(CH_2)$ (2) is produced upon photolysis of the 2-oxametallacycle $Cp^*(PMe_3)Ir(CH_2CMe_2O)$ (1) in toluene solution at low temperature, and is found to be indefinitely stable in solution below −40 °C. The methylene carbon in 2 is quite basic; the reaction of 2 with a variety of organic acids is described. Complex 2 also reacts with non-protic reagents. The synthesis of a variety of iridium and rhodium mono- and bis-thiolate complexes is described. These molecules can be prepared by exchange reactions of organic thiols with $Cp^*(PMe_3)Ir(OEt)H$ (6) or by nucleophilic displacement of metal-bound chloride by sodium alkyl thiolates. Several of these complexes have been characterized by x-ray crystallography. A preliminary study on the chemistry of these compounds is presented which shows that reaction can take place at either the sulfur atom or the metal center.

22225 (N–90-14874) **A diagnostic for determining the quality of single-reference electron correlation methods.** Lee, T.J.; Taylor, P.R. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. 1989. 15p. (NASA-TM–101929;NAS–1.15:101929). Available from NTIS, PC A03/MF A01.

It was recently proposed that the Euclidian norm of the t(sub 1) vector of the coupled cluster wave function (normalized by the number of electrons included in the correlation procedure) could be used to determine whether a single-reference-based electron correlation procedure is appopriate. This diagnostic, T(sub 1) is defined for use with self-consistent-field molecular orbitals and is invariant to the same orbital rotations as the coupled cluster energy. T(sub 1) is investigated for several different chemical systems which exhibit a range of multireference behavior, and is shown to be an excellent measure of the importance of non-dynamical electron correlation and is far superior to C(sub 0) from a singles and doubles configuration interaction wave function. It is further suggested that when the aim is to recover a large fraction of the dynamical electron correlation energy, a large T(sub 1) (i.e., greater than 0.02) probably indicates the need for a multireference electron correlation procedure.

22226 **Characterization of silica-supported ruthenium catalysts by hydrogen chemisorption and nuclear magnetic resonance of adsorbed hydrogen.** Wu, X. (Iowa State Univ., Ames (USA)); Gerstein, B.C.; King, T.S. *Journal of Catalysis (USA)*, 118(1): 238-254 (Jul 1989). DOE Contract W-7405-ENG-82.

Adsorbed hydrogen on four silica-supported ruthenium catalysts was measured quantitatively by proton magnetic resonance (PMR). The PMR technique revealed two distinct adsorbed states of hydrogen on the metal: reversible and irreversible. The results from PMR and those from conventional hydrogen chemisorption measurements were compared directly. The observed discrepancy between the PMR and volumetric techniques in the case of total adsorption is attributed to spillover of reversibly adsorbed hydrogen from ruthenium onto the silica support. Good agreement was obtained between the two techniques in the case of irreversible adsorption. The relatively narrow line of PMR spectra on the reversibly adsorbed hydrogen indicates rapid motion for this state of hydrogen on ruthenium surfaces. The variation of spectral lineshift and of the spin-lattice relaxation times for the adsorbed hydrogen with ruthenium particle size suggests a stronger interaction between the adsorbed hydrogen and defect-like ruthenium adsorption sites. The results from PMR intensity measurements also suggest that the reversibly adsorbed hydrogen is at least in part associated with the defect-like ruthenium adsorption sites.

22227 **Elementary steps in the formation of highly dispersed palladium in NaY. II. Particle formation and growth.** Homeyer, S.T. (Northwestern Univ., Evanston, IL (USA)); Sachtler, W.M.H. *Journal of Catalysis (USA)*, 118(1): 266-274 (Jul 1989).

Calcination conditions which leave Pd ions in Pd/NaY in two reproducible states have previously been defined: Low-temperature calcination (T_C = 250C) leaves $Pd(NH_3)^{2+}_x$ in supercages, but high-temperature calcination (T_C = 500C) places Pd^{2+} quantitatively in sodalite cages. It has now been found that the processes which lead to Pd particle formation during reduction with H_2 are entirely different for these two cases. Reduction of Pd ions in supercages results in the formation of primary particles (d < 7 Å) which rapidly migrate and coalesce to larger particles, whose migration is impeded by the size of the supercage windows. Reduction of Pd ions in sodalite cages, however, leads to the formation of isolated atoms or dimers which are trapped in these cages. Their subsequent release into the supercage network is an activated process. The ratio of adsorbed hydrogen to reduced palladium, in this case, initially increases with temperature, then passes through a maximum, indicating that isolated Pd atoms are incapable of dissociatively chemisorbing H_2.

22228 **Separation of nitrogen and oxygen isotopes by liquid chromatography.** Tanaka, Nobuo (Kyoto Inst. of Tech. (Japan));

Hosoya, Ken; Nomura, Kazuhiro; Yoshimura, Tadanori; Ohki, Takehiro; Yamaoka, Ryohei; Kimata, Kazuhiro; Araki, Mikio. *Nature (London) (UK)*, 341(6244): 727-728 (26 Oct 1989).

Isotopic enrichment of organic compounds in the stable minor isotopes ^{15}N, ^{17}O and ^{18}O, which are often used as tracers, is commonly achieved by syntheses that involve isotopically enriched simple precursors such as NH_3, H_2O and CO_2. But such labelled compounds are not always commercially available or readily synthesized. Here we report the direct enrichment of nitrogen and oxygen isotopes in dissociable compounds such as amines, phenols and carboxylic acids, using a high-performance liquid-chromatography technique. The separation method relies on the isotope effects on the dissociation equilibria of weak acids and bases that occur in protonation or deprotonation of the relevant isotopes. Enrichment of ^{15}N to 5-10% isotopic purity in N,N-dimethylaniline was achieved from the natural abundance of 0.37% in less than 14 hours; subsequent runs brought the isotopic purity to 90% or more. Enrichment of ^{17}O and ^{18}O to similar high purities in p-nitrophenol was also obtained. Thus, where suitable dissociation equilibria exist, direct isotopic enrichment is possible using standard techniques without the need to devise complex synthetic pathways. (author).

4004 Electrochemistry

Refer also to citation(s) 21122, 21878, 21881, 22194, 22868

4005 Photochemistry

Refer also to citation(s) 22871

22229 (DOE/ER/13592–T2) **Photoexcited charge pair escape recombination: Progress report, March 1–November 15, 1989.** Braun, C.L. Dartmouth Coll., Hanover, NH (USA). Dept. of Chemistry. 15 Nov 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13592. Order Number DE90008421. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. ION PAIRS/recombination; PROGRESS REPORT; DISSOCIATION; DURENE; PHOTOIONIZATION; RECOMBINATION; PHOTOCURRENTS

22230 (DOE/ER/13937–2) **[Laser enhanced chemical reactions]: Technical progress report, March 1, 1989–February 28, 1990.** Flynn, G.W. Columbia Univ., New York, NY (USA). 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13937. Order Number DE90008273. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The present report spans the activities for the period March 1, 1989 to February 28, 1990. Included in the report is the discussion of infrared diode lasers used to study time-dependent dynamic events. Also, hot atom excitation of vibrational states of polyatomic molecules, bimolecular quenching and reactions of O^1D, bimolecular reaction studies of the OH + CO → H + CO_2 system, and the chemical dynamics of the reaction between chlorine atoms and deuterated cyclohexane are covered briefly in this report. (JDL)

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 21499, 22211, 22212, 22213, 22230, 22476, 22724, 22858, 22859, 22860

22231 (GSI–89-18) **Studies on the synthesis and characterisation of superheavy elements.** Scherer, U.W. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Mainz Univ. (Germany, F.R.). Jul 1989. 132p. (In German). Order Number DE90759071. Available from NTIS (US Sales Only), PC A07/MF A01.

In the first part of this study fast methods of ion chromatography for testing the chemical properties of the elements 103, lawrencium, and 105 were applied. In the second part of the study these methods were applied to studies on the mechanism of heavy-ion reactions. At the UNILAC of the GSI (Institute for Heavy-Ion Research), Darmstadt, the fusion reaction of ^{48}Ca with ^{208}Pb was tested. The excitation function of the reaction was measured with the velocity filter SHIP. The transmission of the fused cores by SHIP was measured with rapid radiochemical methods. (orig./RB).

22232 (IAE–2060/ORiPI/I/B) **The influence of chosen parameters of iodine-125 produced by IPRC on iodination of adrenocorticotropic hormone (ACTH): The comparison of Nasup 125I preparations produced by three different technological methods.** Blichewicz, G. Institute of Atomic Energy, Otwock-Swierk (Poland). Jun 1988. 23p. (In Polish). Order Number DE90619275. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Received in 1989.

Based on Greenwood and Hunter method of iodination the estimation of protein labelling efficiency for $Na^{125}I$ produced by IPRC was performed. The adrenocorticotropic hormone ($ACTH_{1-24}$) as a standard of protein had been used and iodine-125 preparations produced as well as by wet destillation, dry destillation and chromatographic methods were subject of investigation. The influence of some chosen properties of the preparations on labelling efficiency is discussed and conclusions concerning iodination repeatability as well as influence of storage time on labelling efficiency are presented. 16 refs., 2 figs., 9 tabs. (author).

22233 (LA–11619-Vol.1) **X-ray diffraction data for plutonium compounds: Volume 1, Plutonium and plutonium binary compounds: Pu, H-Se.** Roof, R.B. Los Alamos National Lab., NM (USA). Oct 1989. 434p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008129. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This work is a compilation of x-ray diffraction information relating to powder photographs of plutonium compounds. The information is presented in a format and style substantially as recommended by the International Centre for Diffraction Data. The Los Alamos National Laboratory has been very much involved in the study of the properties of plutonium and its compounds. During the past 45 years the Powder Diffraction File of the Laboratory has grown to more than 20,000 films. F.H. Ellinger and his coworkers have used this data to establish a large number of plutonium binary phase diagrams. A phase diagram, however, should never be regarded as really complete as new techniques of alloy preparation or x-ray and optical metallography continually discover new phases that must be incorporated in the diagram. In addition to the phase diagrams, the crystal structure of a number of plutonium intermetallic compounds have been determined at Los Alamos. Due to the importance of plutonium as a representative of the actinide series of elements, it is deemed advisable to have available information on the x-ray diffraction of plutonium and its compounds for the purpose of identification of these materials. It is hoped that the information presented here will be of value in this regard.

22234 (LA–11619-Vol.2) **X-ray diffraction data for plutonium compounds: Volume 2, Plutonium and plutonium binary compounds: Br-Es.** Roof, R.B. Los Alamos National Lab., NM (USA). Oct 1989. 313p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008139. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This work is a compilation of x-ray diffraction information relating to powder photographs of plutonium compounds. The information is presented in a format and style substantially as recommended by the International Centre for Diffraction Data. The Los Alamos National Laboratory has been very much involved in the study of the properties of plutonium and its compounds. During the past 45 years the Powder Diffraction File of the Laboratory has grown to more than 20,000 films. F.H. Ellinger and his coworkers have used this data to establish a large number of plutonium binary phase diagrams. A phase diagram, however, should never be regarded as really complete as new techniques of alloy preparation or x-ray and optical metallography continually discover new phases that must be incorporated in the diagram. In addition to the phase diagrams, the crystal structure of a number of plutonium intermetallic compounds have been determined at Los Alamos. Due to the importance of plutonium as a representative of the actinide series of elements, it is deemed advisable to have available information on the x-ray

diffraction of plutonium and its compounds for the purpose of identification of these materials. It is hoped that the information presented here will be of value in this regard.

22235 (LBL–28271) **Reaction of Tris(cyclopentadienyl) uranium compounds with amines, azides, and related ligands.** Rosen, R.K. Lawrence Berkeley Lab., CA (USA). Dec 1989. 251p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008494. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

The trivalent uranium compound, $(MeC_5H_4)_3U(thf)$, serves as a one- or two-electron reducing agent towards azides, RN_3. These reactions produce either the uranium(IV) azide, $(MeC_5H_4)_3UN_3$, or uranium(V) imides, $(MeC_5H_4)_3UNR$. The role of steric and electronic effects upon this reaction has been investigated using several series of azides. For Me_3XN_3, the imides are produced when X = C or Si, both products are formed when X = Ge, and the azide is produced when X = Sn. For Ph_3XN_3, the azide is produced when X = C or Sn. For $Ph_{3-x}CH_3N_3$, the imide is produced when x = 2 and both compounds are produced when x = 1. For substituted phenylazides, $RC_6H_4N_3$, only the imides are produced. The magnetic properties of uranium diimides, $[(MeC_5H_4)_3U]_2(\mu\text{-NRN})$, were investigated. Several uranium(III) amines, $(MeC_5H_4)_3U(NH_2R)$, were produced from $(MeC_5H_4)_3U(thf)$ and RNH_2, and NH_3 was found to be a better ligand towards $(MeC_5H_4)_3U$ than is PMe_3.

22236 (RCM–00889) **Thermodynamics and speciation: Solubility of PuO_2 and $Pu(OH)_4$ and electrophoretic speciation of Np ions. Progress report for the CEC project MIRAGE II.** Kim, J.I. (Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie); Kanellakopulos, B.; Mang, M.; Herrmann, G.; Trautmann, N. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Jul 1989. 30p. Contract CEC FI 1W-0202-D(B). Order Number DE90759319. Available from NTIS (US Sales Only), PC A03/MF A01.

This report contains experimental results of two separate subjects: Solubility products of crystalline PuO_2 and amorphous $Pu(OH)_4$ separation of Np oxidation states with continuous electrophoretic ion focusing, which are presented separately in part A and B, respectively. The new solubility products of Pu oxide and hydroxide are determined to be log K_{sp}=-60.20±0.17 and -57.85±0.05, respectively. The free energy of formation for $Pu(OH)_4$(am) is -1141 kJ mol^{-1}. The chemical speciation method using continuous electrophoretic ion focusing has been examined to separate Np(IV) and Np(V) in the picomol contraction under different experimental conditions, i.e. varying pH, complexing agent and medium conductivity. A successful separation of Np ions of two important oxidation states is demonstrated. (orig.).

22237 (RCM–00889, pp. 2-18) **Solubility products of plutonium(IV) oxide and hydroxide.** Kim, J.I. (Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie (Germany, F.R.)); Kanellakopulos, B. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Jul 1989. Contract CEC FI 1W-0202-D(B). In *Thermodynamics and speciation: Solubility of PuO_2 and $Pu(OH)_4$ and electrophoretic speciation of Np ions. Progress report for the CEC project MIRAGE II.* Order Number DE90759319. Available from NTIS (US Sales Only), PC A03/MF A01.

The solubility products of amorphous $Pu(OH)_4$ and crystalline PuO_2 have been determined in 1 M $HClO_4$. The dissolution equilibrium of the hydroxide attained after 45 days is characterized by spectroscopy. The oxide prepared at 900deg C is equilibrated for 3 years and the solution is speciated by spectroscopy as well as TTA extraction, both of which give comparable results. The solubility products of the hydroxide and oxide are found to be log K_{sp}=-57.85±0.05 and -60.20±0.17, respectively. The free energy of formation for $Pu(OH)_4$(am) is calculated to be -1141 kJ mol^{-1}. (orig.).

22238 (RCM–00889, pp. 19-28) **Separation of neptunium oxidation states with continuous electrophoretic ion focusing.** Mang, M. (Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie (Germany, F.R.)); Herrmann, G.; Trautmann, N. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Jul 1989. Contract CEC FI 1W-0202-D(B). In *Thermodynamics and speciation: Solubility of PuO_2 and $Pu(OH)_4$ and electrophoretic speciation of Np ions. Progress report for the CEC project MIRAGE II.* Order Number DE90759319. Available from NTIS (US Sales Only), PC A03/MF A01.

Separation and concentration of the different neptunium oxidation states can be achieved with continuous electrophoretic ion focusing. Differences between complex stability constants of the particular neptunium complexes are used to separate the neptunium oxidation states in an electric field. After preparation of Np(IV) and Np(V) in solution, separation in dependence of pH, complexing agent and conductivity of the samples is investigated. (orig.).

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 21297, 22090, 22195, 22207, 22217

22239 (AD-A–214621/5/XAB) **Combustion of hydrogen and hydrocarbons in fluorine. Final report, 1 August 1984-31 July 1989.** Kaufman, M. Emory Univ., Atlanta, GA (USA). Dept. of Biology. 3 Sep 1989. 29p. Available from NTIS, PC A03/MF A01.

This program is directed towards increasing understanding of combustion processes in general, as well as advancing the application of fluorine-supported combustion in areas such as propulsion and chemical lasers. Since fluorine is monovalent, combustion in fluorine is chemically much simpler than combustion in oxygen. However, in fluorine-based combustion most of the energy is initially deposited into vibration (of HF), and transfer of energy from vibrationally excited species must be considered. Experiments in H2-F2 flames to which very small amounts of methane have been added are particularly revealing and indicate that the most-likely mechanism for explaining luminescence from CH and CHF radicals in these flames is vibration-to-electronic energy transfer from highly vibrationally excited HF. C2 emission probably results from the CH + CH yields C2* + H2 reaction. These conclusions suggest that the ratio I(CH)/(ICH2)1/2 is a useful diagnostic for vibrationally excited HF in H2-F2 propulsion and laser systems. Ionization is not intrinsic to fluorine-hydrocarbon combustion, but often results from oxygen impurity in fluorine. Fluorine combustion systems show a variety of nonsteady behaviors, which are postulated to be due to changes in concentrations of vibrationally excited species in the system. The method of kinetic titrations was developed to obtain stoichiometric, kinetic, and mechanistic information about chemical reactions.

22240 (DOE/ER/13400–9) **Identification and temporal behavior of radical intermediates formed during the combustion and pyrolysis of gaseous fuels: Kinetic pathways to soot formation: Progress report, July 1, 1989–June 30, 1990.** Kern, R.D.; Xie, K.; Chen, H. New Orleans Univ., LA (USA). Dept. of Chemistry. Feb 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13400. Order Number DE90008412. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Our work has continued as outlined in our research proposal which covered the period July 1, 1988–June 30, 1991. There have been no major departures from the proposed plan. Included in this report is a budget for the period July 1, 1990–June 1991. The funds requested reflect a reduction from the original amount, $76,119 instead of $77,200. The main focus of our work continues to be the formulation of reaction mechanisms for pyrolytic reaction systems that pertain to the soot formation process. Several important developments have caused us to re-examine our previous results on the thermal decomposition of acetylene. A shock tube coupled to a time-of-flight (TOF) mass spectrometer was used to obtain the dynamic reaction profiles for C_2H_2, C_4H_2 and C_6H_2 during the course of the available observation period (~ 1 μs). The results were modeled over a wide range of temperatures and initial concentrations of C_2H_2.

22241 (LBL–27905) **Symposium on high temperature and materials chemistry.** Lawrence Berkeley Lab., CA (USA). Oct 1989. 252p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8910302–1: Symposium on high temperature and materials chemistry, Berkeley, CA (USA), 24-25

Oct 1989). Order Number DE90008047. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

This volume contains the written proceedings of the Symposium on High Temperature and Materials Chemistry held in Berkeley, California on October 24–25, 1989. The Symposium was sponsored by the Materials and Chemical Sciences Division of Lawrence Berkeley Laboratory and by the College of Chemistry of the University of California at Berkeley to discuss directions, trends, and accomplishments in the field of high temperature and materials chemistry. Its purpose was to provide a snapshot of high temperature and materials chemistry and, in so doing, to define status and directions.

22242 (N–90-13589) **LOX/hydrocarbon combustion instability investigation. Final report.** Jensen, R.J.; Dodson, H.C.; Claflin, S.E. Rockwell International Corp., Canoga Park, CA (USA). Jul 1989. 177p. (NASA-CR–182249;RI/RD–89-179;NAS–1.26:182249). Available from NTIS, PC A09/MF A02.

The LOX/Hydrocarbon Combustion Instability Investigation Program was structured to determine if the use of light hydrocarbon combustion fuels with liquid oxygen (LOX) produces combustion performance and stability behavior similar to the LOX/hydrogen propellant combination. In particular methane was investigated to determine if that fuel can be rated for combustion instability using the same techniques as previously used for LOX/hydrogen. These techniques included fuel temperature ramping and stability bomb tests. The hot fire program probed the combustion behavior of methane from ambient to subambient temperatures. Very interesting results were obtained from this program that have potential importance to future LOX/methane development programs. A very thorough and carefully reasoned documentation of the experimental data obtained is contained. The hot fire test logic and the associated tests are discussed. Subscale performance and stability rating testing was accomplished using 40,000 lb. thrust class hardware. Stability rating tests used both bombs and fuel temperature ramping techniques. The test program was successful in generating data for the evaluation of the methane stability characteristics relative to hydrogen and to anchor stability models. Data correlations, performance analysis, stability analyses, and key stability margin enhancement parameters are discussed.

22243 (N–90-13747) **Numerical solutions of the complete Navier-Stokes equations. Progress report No. 16, 1 July 1988-31 December 1989.** Hassan, H.A. North Carolina State Univ., Raleigh, NC (USA). Dec 1989. 16p. (NASA-CR–186102;NAS–1.26:186102). Available from NTIS, PC A03/MF A01.

A hybrid Reynolds averaged/assumed probability density function (PDF) approach was developed and applied to the study of turbulent combustion in a supersonic mixing layer. This approach was used to address the laminar-like treatment of the thermochemical terms that appear in the conservation equations. Calculations were carried out for two experiments involving H2-air supersonic turbulent mixing. A SPARK combustion model was employed. In general, the approach shows modest improvement over previous calculations.

22244 (N–90-14305) **Kinetics and mechanism of soot formation in hydrocarbon combustion. Final Technical report, 25 October 1985-28 February 1989.** Frenklach, M. Pennsylvania State Univ., University Park, PA (USA). Davey Lab. Jan 1990. 10p. (NASA-CR–186162;NAS–1.26:186162). Available from NTIS, PC A02/MF A01.

The focus of this work was on kinetic modeling. The specific objectives were: detailed modeling of soot formation in premixed flames, elucidation of the effects of fuel structure on the pathway to soot, and the development of a numerical technique for accurate modeling of soot particle coagulation and surface growth. Those tasks were successfully completed and are briefly summarized.

22245 **Multiphoton excitation techniques in combustion diagnostics.** Goldsmith, J.E.M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

Multiphoton excitation provides spectroscopic access to several species that are very important in flame studies, but that cannot be detected in combustion environments using conventional optical techniques. This paper describes applications of multiphoton excitation techniques for detecting such species in combustion environments, with an emphasis placed on measurements of atomic hydrogen in flames.

22246 **Ein Gedi Workshop on Combustion, Ein Gedi, Israel, Feb. 1988, Proceedings.** *Combustion and Flame (USA)*, 78: 179 (Oct 1989). (CONF-8802160–: Ein Gedi workshop on combustion, Ein Gedi (Israel), Feb 1988).

Papers are presented on the dynamics of elementary processes and combustion kinetics, how to attack complex gas phase combustion systems, gas pyrolysis in combustion single-pulse shock tube studies of N- and O-atom-containing heterocyclics, the present state of predicting limiting high-pressure rate coefficients for pyrolysis reactions, rate constants for the decomposition and formation of simple alkanes over extended temperature and pressure ranges, and thermokinetic combustion oscillations as an alternative to thermal explosion. Attention is also given to the modeling of inhomogeneities in the toroidal jet-stirred reactor, rotational effects in density-stratified reacting gases, velocity measurements in inhomogeneous combustion systems, semiquantitative laser-induced fluorescence in flames, and comparisons between flame species measured by probe sampling and optical spectrometry techniques.

42 ENGINEERING

Refer also to citation(s) 23257

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 21458, 21469, 22036, 22038, 22040, 22128, 22199, 22330, 23229, 23254

22247 (CONF-900559–5) **Concept formation and generalization based on experimentation by an autonomous mobile robot.** Spelt, P.F.; deSaussure, G.; Lyness, E.; Oliver, G.; Silliman, M. Oak Ridge National Lab., TN (USA). Center for Engineering Systems Advanced Research. [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CESAR–89/41). From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90001731. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Center for Engineering Systems Advanced Research (CESAR) conducts basic research in the area of intelligent machines. In this paper, we describe our approach to a class of machine learning problems which involves autonomous concept formation using feedback from trial-and-error learning. Our formulation was experimentally validated on an autonomous mobile robot, which learned the task of control panel monitoring and manipulation for effective process control. Conclusions are drawn concerning the applicability of the system to a more general class of learning problems, and implications for the use of autonomous mobile robots in hostile and unknown environments are discussed. 9 refs., 5 figs.

22248 (CONF-900559–7) **Robot navigation research using the HERMIES mobile robot.** Barnett, D.L. Oak Ridge National Lab., TN (USA). [1989]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90001952. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In recent years robot navigation has attracted much attention from researchers around the world. Not only are theoretical studies being simulated on sophisticated computers, but many mobile robots are now used as test vehicles for these theoretical studies. Various algorithms have been perfected for navigation in a known static environment; but navigation in an unknown and dynamic environment poses a much more challenging problem for researchers. Many different methodologies have been developed for autonomous robot navigation, but each methodology is usually restricted to a particular type of environment. One important research

focus of the Center for Engineering Systems Advanced research (CESAR) at Oak Ridge National Laboratory, is autonomous navigation in unknown and dynamic environments using the series of HERMIES mobile robots. The research uses an expert system for high-level planning interfaced with C-coded routines for implementing the plans, and for quick processing of data requested by the expert system. In using this approach, the navigation is not restricted to one methodology since the expert system can activate a rule module for the methodology best suited for the current situation. Rule modules can be added the rule base as they are developed and tested. Modules are being developed or enhanced for navigating from a map, searching for a target, exploring, artificial potential-field navigation, navigation using edge-detection, etc. This paper will report on the various rule modules and methods of navigation in use, or under development at CESAR, using the HERMIES-IIB robot as a testbed. 13 refs., 5 figs., 1 tab.

22249 (CONF-900559–8) **Robust performance of multiple tasks by a mobile robot.** Beckerman, M. (Oak Ridge National Lab., TN (USA)); Barnett, D.L.; Dickens, M.; Weisbin, C.R. Oak Ridge National Lab., TN (USA); Jet Propulsion Lab., Pasadena, CA (USA). [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90001953. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

While there have been many successful mobile robot experiments, only a few papers have addressed issues pertaining to the range of applicability, or robustness, of robotic systems. The purpose of this paper is to report results of a series of benchmark experiments done to determine and quantify the robustness of an integrated hardware and software system of a mobile robot. 8 refs., 6 figs., 2 tabs.

22250 (CONF-900559–12) **Design of a telerobotic controller with joint torque sensors.** Jansen, J.F.; Herndon, J.N. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by National Aeronautics and Space Administration. DOE Contract AC05-84OR21400. From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90008753. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this paper is to analytically show how to design a joint controller for a telerobotic system when joint torque sensors are available. Other sensors such as actuator position, actuator velocity, joint position, and joint velocity are assumed to be accessible; however, the results of this paper will also be useful when only partial measurements are available. The controller presented in this paper can be applied to either mode of operation of a manipulator (i.e., teleoperation or robotic). Mechanical manipulators with high levels of friction are assumed in this study. Finally, the results are applied to a telerobotic system built for NASA. Very high levels of friction have been reduced using high-grain feedback while avoiding limit cycles. 14 refs., 5 figs.

22251 (DOE/EH/79072–T3) **Fire protection review revisit No. 2, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.** Dobson, P.H.; Keller, D.R.; Treece, S.D. Factory Mutual Research Corp., Norwood, MA (USA). Feb 1990. 78p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC01-88EH79072. Order Number DE90007558. Available from NTIS, PC A05/MF A01 - OSTI.

A fire protection survey was conducted for the Department of Energy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, from October 30–November 4, November 6–10, and December 4–8, 1989. The purpose of the survey was to review the facility fire protection program and to make recommendations. Surveys of other facilities resulted in a classification system for buildings which provide an indication of the importance of the building to the fulfillment of the mission of the facility. Recommendations in this report reflect to some degree the relative importance of the facility and the time to restore it to useful condition in the event a loss were to occur.

22252 (EPRI-NP–6697) **A compendium of robotic equipment used in hazardous environments: Final report.** Brittain, K.R. (Jones (J.A.) Applied Research Co., Charlotte, NC (USA)); Evans, S.O.; Sturkey, R.F. Electric Power Research Inst., Palo Alto, CA (USA); Jones (J.A.) Applied Research Co., Charlotte, NC (USA). c Feb 1990. 548p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents a compendium of information regarding specific robotic/teleoperated devices that can be employed in various hazardous environments. A number of the devices were developed for the power industry, while others were designed for non-power related industries, such as space or underwater but may have applications in electricity generating stations. These devices can be used to inspect, locate, identify, manipulate, and/or maintain components in a hazardous environment as well as act as mobile surveillance/sensing/reconnaissance platforms while monitoring the various elements in that atmosphere. Furthermore, they can be used to transport tools, equipment, and material to and from the hazardous environment. This compendium includes remote terrestrial vehicles (RTVs), underwater remotely operated vehicles (ROVs), ROVs suitable for power plant applications; remote pipe crawlers (RPCs), and remote manipulator system (RMSs). The information contained in this report represents a snapshot of this evolving technology, and the devices shown are those for which general information and specification could be obtained at this time. 172 figs.

22253 (JAERI-M–89-137) **The development of computational algorithms for manipulator inverse kinematics.** Sasaki, Shinobu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 107p. (In Japanese). Order Number DE90759877. Available from NTIS (US Sales Only), PC A06/MF A01.

A solution technique of the inverse kinematics for multi-joint robot manipulators has been considered to be one of the most cumbersome treatment due to non-linearity properties inclusive of trigonometric functions. The most traditional approach is to use the Jacobian matrix on linearization assumptions. This iterative technique, however, is attended with numerical problems having significant influences on the solution characteristics such as initial guess dependence and singularities. Taking these facts into consideration, new approaches have been proposed from different standpoints, which are based on polynomial transformation of kinematic model, the minimization technique in mathematical programming, vector-geometrical concept, and the separation of joint variables associated with the optimization problem. In terms of computer simulations, each approach was identified to be a useful algorithm which leads to theoretically accurate solutions to complicated inverse problems. In this way, the short-term goal of our studies on manipulator inverse problem in the R and D project of remote handling technology was accomplished with success, and consequently the present report sums up the results of basic studies on this matter. (author).

22254 (JAERI-M–89-140) **A revision of MUTUAL, a computer code for analysing nuclear criticality safety on array system.** Okuno, Hiroshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Naito, Yoshitaka; Kaneko, Toshiyuki; Kuribayashi, Katsuaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 36p. Order Number DE90759878. Available from NTIS (US Sales Only), PC A03/MF A01.

MUTUAL is a computer code for analysing nuclear criticality safety on array system. Its original version was published in 1986. It has been revised in the following three aspects: (1) the input format has been changed from the original BOX-type to the absolute coordinate type; (2) the eigen equation has been changed to obtain the maximum eigenvalue from that to obtain the minimum; (3) subroutines to calculate solid angles have been improved to correctly take into account the contribution to the solid angles from imaginary units. This report is a user's manual of the revised MUTUAL code. (author).

22255 (JAERI-M–89-170) **Annual report of Special Committee on Nuclear Criticality Safety.** Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 35p. (In Japanese). Order Number

DE90759893. Available from NTIS (US Sales Only), PC A03/MF A01.

Special committee on Nuclear Criticality Safety was established in November 1989 and the period is 2 years. The main subjects of this committee are the estimation of experimental data on critically safety, the investigation of the abnormal conditions in fuel treatment process, the criticality safety control and surveillance techniques, and examination of criticality safety experiments. The document is concerning with the activity of this committee of the first year. (author).

22256 (JAERI-M–89-191) **Adaptive learning fuzzy control of a mobile robot.** Tsukada, Akira (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Katsuo; Fujii, Yoshio; Shinohara, Yoshikuni. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 29p. (In Japanese). Order Number DE90759898. Available from NTIS (US Sales Only), PC A03/MF A01.

In this report a problem is studied to construct a fuzzy controller for a mobile robot to move autonomously along a given reference direction curve, for which control rules are generated and acquired through an adaptive learning process. An adaptive learning fuzzy controller has been developed for a mobile robot. Good properties of the controller are shown through the travelling experiments of the mobile robot. (author).

22257 (LA-UR–90-590) **Nonoptimal entropy generation by heat transfer in cryogenic domain.** Sekulic, D.P (Novi Sad Univ. (Yugoslavia) Dept. of Mechanical Engineering); Edeskuty, F.J. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. Department of Defense; US-Yugoslav Joint Fund for Scientific and Technological Cooperation. DOE Contract W-7405-ENG-36. (CONF-900508–1: FLOWERS '90: Florence world energy research symposium, Florence (Italy), 28 May - 1 jun 1990). Order Number DE90007544. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The entropy generation caused by heat conduction has been analyzed for physical situations related to cryostats. The situations under consideration are characterized by heat conduction with presence or absence of heat generation and/or heat convection. The existing information regarding the thermodynamic optimal design is compared with more realistic nonoptimal situations. The difference between the optimal and nonoptimal entropy generation has been analyzed from the quantitative point of view. It has been shown that the nonoptimal temperature distribution through a cryostat component might be a realistic option from the thermal design point of view. 13 refs., 5 figs., 1 tab.

22258 (N–90-13590) **Tank pressure control experiment on the space shuttle.** National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 11p. (NASA-TM–102313;E–5007;NAS–1.15:102313). Available from NTIS, PC A03/MF A01.

The tank pressure control experiment is a demonstration of NASA intent to develop new technology for low-gravity management of the cryogenic fluids that will be required for future space systems. The experiment will use freon as the test fluid to measure the effects of jet-induced fluid mixing on storage tank pressure and will produce data on low-gravity mixing processes critical to the design of on-orbit cryogenic storage and resupply systems. Basic data on fluid motion and thermodynamics in low gravity is limited, but such data is critical to the development of space transfer vehicles and spacecraft resupply facilities. An in-space experiment is needed to obtain reliable data on fluid mixing and pressure control because none of the available microgravity test facilities provide a low enough gravity level for a sufficient duration to duplicate in-space flow patterns and thermal processes. Normal gravity tests do not represent the fluid behavior properly; drop-tower tests are limited in length of time available; aircraft low-gravity tests cannot provide the steady near-zero gravity level and long duration needed to study the subtle processes expected in space.

22259 (ORNL/FTR–3539) **[Environmental protection for hazardous materials incidents]: Foreign trip report, February 4, 1990–February 9, 1990.** Barkenbus, B.D. Oak Ridge National Lab., TN (USA). 16 Feb 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007454. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Traveler attended the US Air Force Europe (USAFE) Engineering and Services Conference. The purpose of the travel was to introduce the Environmental Protection for Hazardous Materials Incidents project to the fire chiefs in Engineering and Services community. This project was initiated to provide the US Air Force fire protection community with an integrated program to handle hazardous materials and hazardous material incidents.

22260 (SAND–89-2044C) **Knowledge-based robotic grasping.** Stansfield, S.A. Sandia National Labs., Albuquerque, NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–9: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90007216. Available from NTIS, PC A02/MF A01 - OSTI.

In this paper, we describe a general-purpose robotic grasping system for use in unstructured environments. Using computer vision and a compact set of heuristics, the system automatically generates the robot arm and hand motions required for grasping an unmodeled object. The utility of such a system is most evident in environments where the robot will have to grasp and manipulate a variety of unknown objects, but where many of the manipulation tasks may be relatively simple. Examples of such domains are planetary exploration and astronaut assistance, undersea salvage and rescue, and nuclear waste site clean-up. This work implements a two-stage model of grasping: stage one is an orientation of the hand and wrist and a ballistic reach toward the object; stage two is hand preshaping and adjustment. Visual features are first extracted from the unmodeled object. These features and their relations are used by an expert system to generate a set of valid reach/grasps for the object. These grasps are then used in driving the robot hand and arm to bring the fingers into contact with the object in the desired configuration. 16 refs., 14 figs.

22261 (SAND–89-2106) **Moisture control in sealed electronic packages.** Keenan, M.R. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 68p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008136. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A number of issues associated with controlling the internal moisture content of sealed packages are examined. The basic strategy for maintaining a dry internal environment is to incorporate desiccant into the package and it is shown that molecular sieves are well suited to this task. Expressions are developed that predict the moisture content of the package in terms of package design and the external storage environment. Both moisture sealed into the package during assembly and water tht leaks or permeates into the package over its lifetime are accounted for. In this development, the temperature dependences of all quantities of interest are explicitly treated and the actual Langmuir-like adsorption isotherm exhibited by molecular sieves is employed. These equations allow the quantity of desiccant required to meet design objectives to be computed. They also permit one to evaluate the sensitivity of the internal environment to design parameters and storage conditions, and a number of these are discussed. A computer program that has been written to perform these calculations is also described. 32 refs., 33 figs., 4 tabs.

22262 (SAND–89-2414C) **Resolved motion rate and resolved acceleration servo-control of wheeled mobile robots.** Muir, P.F. (Sandia National Labs., Albuquerque, NM (USA)); Neuman, C.P. Sandia National Labs., Albuquerque, NM (USA). [1989]. 20p. Sponsored by Carnegie-Mellon University; U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. N00014-81-K-0503. (CONF-900559–1: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90002585. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Accurate motion control of wheeled mobile robots (WMRs) is required for their application to autonomous, semi-autonomous and teleoperated tasks. The similarities between WMRs and stationary

manipulators suggest that current, successful, model-based manipulator control algorithms may be applied to WMRs. Special characteristics of WMRs including higher-pairs, closed-chains, friction and unactuated and unsensed joints require innovative modeling methodologies. The WMR modeling challenge has been recently overcome, thus enabling the application of manipulator control algorithms to WMRs. This realization lays the foundation for significant technology transfer from manipulator control to WMR control. We apply two Cartesian-space manipulator control algorithms: resolved motion rate (kinematics-based) and resolved acceleration (dynamics-based) control to WMR servo-control. We evaluate simulation studies of two exemplary WMRs: Uranus (a three degree-of-freedom WMR constructed at Carnegie Mellon University), and Bicsun-Bicas (a two degree-of-freedom WMR being constructed at Sandia National Laboratories) under the control of these algorithms. Although resolved motion rate servo-control is adequate for the control of Uranus, resolved acceleration servo-control is required for the control of the mechanically simpler Bicsun-Bicas because it exhibits more dynamic coupling and nonlinearities. Successful accurate motion control of these WMRs in simulation is driving current experimental research studies. 18 refs., 7 figs., 5 tabs.

22263 (SAND–89-2494C) **An object-oriented environment for robot system architectures.** Miller, D.J.; Lennox, R.C. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–11: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90008311. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An object-oriented Robot Independent Programming Environment (RIPE) developed at Sandia National Laboratories is being used for rapid design and implementation of a variety of applications. A system architecture based on hierarchies of distributed multiprocessors provides the computing platform for a layered programming structure that models the application as a set of software objects. These objects are designed to support model-based automated planning and programming, real-time sensor-based activity, error handling, and robust communication. The object-oriented paradigm provides mechanisms such as inheritance and polymorphism which allow the implementation of the system to satisfy the goals of software reusability, extensibility, reliability, and portability. By designing a hierarchy of generic parent classes and device-specific subclasses which inherit the same interface, a Robot Independent Programming Language (RIPL) is realized. Work cell tasks demonstrating robotic cask handling operations for nuclear waste facilities are successfully implemented using this object-oriented software environment. 22 refs., 8 figs.

22264 (SAND–89-2506C) **Dynamic damping control: Implementation issues and simulation results.** Anderson, R.J. Sandia National Labs., Albuquerque, NM (USA). [1989]. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–10: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90007687. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Computed torque algorithms are used to compensate for the changing dynamics of robot manipulators in order to ensure that a constant level of damping is maintained for all configurations. Unfortunately, there are three significant problems with existing computed torque algorithms. First, they are nonpassive and can lead to unstable behavior; second, they make inefficient use of actuator capability; and third, they cannot be used to maintain a constant end-effector stiffness for force control tasks. Recently, we introduced a new control algorithm for robots which, like computed torque, uses a model of the manipulator's dynamics to maintain a constant level of damping in the system, but does so passively. This new class of passive control algorithms has guaranteed stability properties, utilizes actuators more effectively, and can also be used to maintain constant end-effector stiffness. In this paper, this approach is described in detail, implementation issues are discussed, and simulation results are given. 15 refs., 6 figs., 2 tabs.

22265 (SAND–89-2510C) **Boundary equations of configuration obstacles for manipulators.** Hwang, Yong K. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–6: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90002101. Available from NTIS, PC A02/MF A01 - OSTI.

Configuration obstacle is an important idea for motion planning. Explicit expressions of configuration obstacles have been available for rigid polyhedral robots and planar polygonal manipulators. In this paper, such expressions are derived for arbitrary manipulators in three-dimensional polyhedral environments. The expressions can be used to compute configuration obstacles or to analyze the geometry of contacts between manipulators and obstacles. 8 refs., 4 figs.

22266 (SAND–89-2511C) **Swing-free movement of simply suspended objects employing parameter estimation.** Werner, J.C.; Robinett, R.D.; Petterson, B.J. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–3: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90002238. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An adaptive, swing-free trajetory planner for a gantry robot has been analytically developed and experimentally implemented on a commercial robot. A batch, nonlinear least square estimator (differential correction) is used to predict the initial conditions, mass, and frequency of the simply suspended object from a set of force sensor measurements. These parameters, in turn, are supplied to the swing-free trajectory planner to perform the maneuver. These algorithms have been implemented on a CIMCORP XR6100 gantry robot, and swing-free trajectories have been performed by the robot using the adaptive trajectory planner.

22267 (SAND–89-2522C) **Parameter-scheduled trajectory planning for suppression of coupled horizontal and vertical vibrations in a flexible rod.** Petterson, B.J.; Robinett, R.D.; Werner, J.C. Sandia National Labs., Albuquerque, NM (USA). [1989]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–2: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90002313. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Angularly accelerating a cantilevered rod which sags under gravity couples the out-of-plane dynamics of the flexible rod and causes oscillation in both the horizontal and vertical planes. A parameter-scheduled trajectory planner has been analytically developed and experimentally implemented on a commercial robot to suppress the first mode of these vibrations during a horizontal angular move. A load was attached to the tip of the rod and the resulting static, out-of-plane, hub torque was measured with a force-torque sensor. This torque was used to predict the period of the horizontal first mode of vibration of the payload (rod and attached load) from a nonlinear function in order to calculate (schedule) the appropriate control parameters for the angular move. This system has been implemented on a Cincinnati Milacron T3-786 robot, and vibration suppressed trajectories (which reduce the coupled residual vibrations by over 90%) have been performed by the robot for various payloads. 9 refs., 3 figs., 2 tabs.

22268 (SAND–89-2527C) **Estimation of modeled object pose from monocular images.** Ray, L.P. Sandia National Labs., Albuquerque, NM (USA). [1989]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900559–4: IEEE robotics and automation conference, Cincinnati, OH (USA), 13-18 May 1990). Order Number DE90001678. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The application of one or more monocular images to estimate the three-dimensional position of objects in investigated. The identities of the objects are known, and geometric models are assumed to be available. Linear features extracted from sensor data are interpreted as corresponding with model features by search of an interpretation tree built using prior position estimates. Object positions are updated by maximum-likelihood estimation. Position estimation results from an implemented system are presented,

demonstrating location of partially occluded objects in a cluttered scene. 19 refs., 8 figs., 3 tabs.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 21871, 21996, 22215, 22402, 23237

22269 (AD-A-214620/7/XAB) **Construct a linac/storage ring FEL facility. Final report, 15 December 1983-14 July 1988.** Madey, J.M. Stanford Univ., CA (USA). Dept. of Electrical Engineering. Aug 1989. 7p. Available from NTIS, PC A02/MF A01.

Components of a 1-GeV electronic storage ring and linac injector were designed, studied, and evaluated. The principal objective was to the development of a high-brightness storage ring and linac injector for use in advanced XUV FEL and synchrotron radiation research and as a source of high-brightness electron beams for the development of other advanced short-wavelength radiation sources. The list of components developed with AF-12 support include: 1. a high-brightness microwave gun for the linac injector; 2. a long-pulse high-power modulator for the linac injector; 3. a short pulse high power modulator for the linac; 4. the control chassis for the long- and short-pulse modulators; 5. a high power pressurized waveguide feed system for the SLAC-type S-Band accelerator sections; 6. quadrupole lenses for the linac; 7. mechanical supports and alignment fixtures for the linac's accelerator sections; 8. the dipole, quadrupole, and sextupole magnets for the ring; 9. the water-cooled vacuum chambers for the arcs of the ring; and 10. the beam-position monitors for the arcs of the ring.

22270 (AD-A-214769/2/XAB) **Capillary flow properties of mesh wicks. Interim report, July 1987-August 1988.** Amborse, J.H.; Chow, L.C. Kentucky Univ., Lexington, KY (USA). Dept. of Mechanical Engineering. Jul 1989. 43p. Available from NTIS, PC A03/MF A01.

Prediction of heat-pipe behavior is extremely important in the design of thermal control for all types of spacecraft. Heat pipes are an important element in spacecraft thermal control. Heat pipes may be subjected to pulsed-heat loading or rapid transients. Previous work in this area has pointed out the need for detailed modeling of the liquid flow in the wick. The amount of liquid in any portion of the wick depends not only on the instantaneous heat input and rejection, but on the loading history. Development of a detailed liquid flow model depends upon knowledge of the saturation dependence of the flow properties, because the detailed flow model accounts for the variation in the saturation in the wick with position and time. This report describes a research effort to determine the saturation dependence of the flow properties in a heat pipe wick. The report is divided into three sections covering the x-ray saturation measurement system, the measurement of capillary pressure and the measurement of relative permeability. The objective of the present investigation is to measure the saturation dependence of the capillary flow properties for multilayer, square mech screen wicks. X-ray radiography is used to measure the saturation in the wicks. Results are presented for the capillary pressure and saturation relationship from steady-state tests. The capillary pressure curves are shown to correlate well when cast in terms of the dimensionless Leverett function. Results of transient wicking rise tests are also presented. The transient saturation distributions are used to calculate the relative permeability of the partially saturated wick structures.

22271 (AD-A-214937/5/XAB) **Design manual for microgravity two-phase flow and heat transfer. Final report, September 1988-June 1989.** Crowley, C.J.; Izenson, M.G. Creare, Inc., Hanover, NH (USA). Oct 1989. 143p. (TM-1309). Available from NTIS, PC A07/MF A01.

This report documents two-phase fluid flow and heat-transfer methods for microgravity environments. The applications of the work are thermal management, propulsion, and fluid storage and transfer systems for spacecraft. In the near future, these systems will include two-phase, vapor-liquid flows. This Design Manual is intended for use by designers of these systems. Design methods are presented for predicting two-phase flow regimes and pressure drops in pipe flows from earth gravity to microgravity conditions. Forced-convection boiling-heat transfer methods for pipes with uniform heat flux are included. Also included are methods for analyzing high-vapor-shear condensation in pipes. The analysis methods are mechanistic; that is, based upon fundamental physical principles which should apply to heat-transfer liquids with Pr approx = 1 and scale with pipe size and fluid properties. This manual incorporates simplified methods (easy-to-use design charts), detailed descriptions of the analysis methods, comparisons with existing microgravity data, and recommended approaches to quantify the range of uncertainty in design calculations.

22272 (N-90-13387) **Application of a two-dimensional unsteady viscous analysis code to a supersonic throughflow fan stage.** Steinke, R.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Nov 1989. 18p. (NASA-TM-4141;E-4848;NAS-1.15:4141). Available from NTIS, PC A03/MF A01.

The Rai ROTOR1 code for two-dimensional, unsteady viscous flow analysis was applied to a supersonic throughflow fan stage design. The axial Mach number for this fan design increases from 2.0 at the inlet to 2.9 at the outlet. The Rai code uses overlapped O- and H-grids that are appropriately packed. The Rai code was run on a Cray XMP computer; then data postprocessing and graphics were performed to obtain detailed insight into the stage flow. The large rotor wakes uniformly traversed the rotor-stator interface and dispersed as they passed through the stator passage. Only weak blade shock losses were computerd, which supports the design goals. High viscous effects caused large blade wakes and a low fan efficiency. Rai code flow predictions were essentially steady for the rotor, and they compared well with Chima rotor viscous code predictions based on a C-grid of similar density.

22273 (N-90-14844) **On the application of subcell resolution to conservation laws with stiff source terms.** Chang, S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Nov 1989. 14p. (NASA-TM-102384;E-5123;ICOMP-89-27;NAS-1.15:102384). Available from NTIS, PC A03/MF A01.

LeVeque and Yee recently investigated a one-dimensional scalar conservation law with stiff source terms modeling the reacting flow problems and discovered that for the very stiff case most of the current finite difference methods developed for non-reacting flows would produce wrong solutions when there is a propagating discontinuity. A numerical scheme, essentially nonoscillatory/subcell resolution - characteristic direction (ENO/SRCD), is proposed for solving conservation laws with stiff source terms. This scheme is a modification of Harten's ENO scheme with subcell resolution, ENO/SR. The locations of the discontinuities and the characteristic directions are essential in the design. Strang's time-splitting method is used and time evolutions are done by advancing along the characteristics. Numerical experiment using this scheme shows excellent results on the model problem of LeVeque and Yee. Comparisons of the results of ENO, ENO/SR, and ENO/SRCD are also presented.

22274 (PSI-42) **Rewetting phenomena and their relation to intermolecular forces between a hot wall and the fluid.** Gerweck, V. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Dec 1989. 124p. Order Number DE90620070. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The rewetting phenomena and the different physical concepts which are used in their modelisation are reviewed. The present work studies the effect of the intermolecular forces between the hot wall and the fluid on this phase transition. Using suitable approximations, a local equation of state is obtained by the treatment of the fluid-fluid and fluid-wall intermolecular interactions. This local equation of state depends on the distance from the wall, and the critical pressure and temperature become a function of the distance from the wall, whereas the critical density is left constant throughout the fluid. At the wall, the critical pressure and temperature are half their bulk values and increase towards the bulk value as the distance from the wall increases. The penetration of a temperature profile in this fluid is studied by assuming that the liquid density is not strongly affected by this temperature profile as long as there is no phase transition. It is shown that the phase transition will occur extremely rapidly when the interfacial temperature upon

contact is higher than the minimum of the local spinodal temperature, which varies with the distance from the wall. The result ist cast in the form of an interfacial rewetting temperature fT_c above which rewetting of the surface by liquid-wall contacts is not expected because these contacts will be terminated in extremely short times. Comparing the theory with available data shows that in the usual rewetting situations the theory reduces to the use of the bulk spinodal temperature. For surfaces coated with poorly wetted materials the correction factor due to surface effects applies, reducing the rewetting temperature, in agreement with the experimental data. 43 figs., 11 tabs., 105 refs.

22275 (SAND–90-0495C) **A view for security: Thermal imagers.** Beckmann, R.C. (Sandia National Labs., Albuquerque, NM (USA)); Pritchard, D.A.; Karst, J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900396–1: IRIS Specialty Group meeting on passive sensors and atmospheric physics, Laurel, MD (USA), 13 Mar 1990). Order Number DE90007275. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The use of thermal imagers in everyday security application has been, until recently, very limited. The last several years have seen an increased use of existing military inventory and commercial imagers to satisfy a variety of security and surveillance needs. This paper discusses the recent history of applying today's available thermal imagers to security related problems. It discusses the problems, and summarizes the current status of imager applied to security and suggests images features which would make them more useful to security applications. 2 refs.

22276 (UCRL–102966) **Hydrodynamic interactions and transport coefficients in a suspension of spherical particles.** Ladd, A.J.C. Lawrence Livermore National Lab., CA (USA). Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8908158–3: Conference on microscopic simulation of complex flows, Brussels (Belgium), 21-25 Aug 1989). Order Number DE90008301. Available from NTIS, PC A02/MF A01 - OSTI.

Particulate suspensions of solids in liquids can be understood in terms of the microstructure of the solid phase by using the well-known techniques of numerical statistical mechanics. The major problem with such an approach has been the incorporation of the long-range, many-body hydrodynamic forces between the suspended particles. In this paper I describe a general computational method for calculating the forces and torques exerted by slowly moving spheres suspended in an incompressible fluid. The method can be used to determine bulk constitutive properties of solid-fluid suspensions or particulate porous media. Numerical results for the sedimentation velocity and high frequency viscosity of monodisperse suspensions have been obtained, and the results are shown to compare very well with experimental measurement. 18 refs., 1 fig., 2 tabs.

22277 **The effect of embedded longitudinal vortex pairs on turbulent boundary layer heat transfer.** Pauley, W.R. (Stanford Univ., CA (USA). Dept. of Mechanical Engineering); Eaton, J.K. pp. 921 of Transport phenomena in turbulent flows: Theory, experiment, and numerical simulation. Hirata, M.; Kasagi, N. Hemisphere Publishing, New York, NY (1988). (CONF-8710415–: 2. international symposia on transport phenomena in turbulent flows: theory, experiment, and numerical simulation, Tokyo (Japan), Oct 1987).

The authors present heat transfer and fluid mechanics data obtained for turbulent boundary layers containing counter-rotating longitudinal vortex pairs with the secondary flow between them directed toward the wall. The data show that embedded vortex pairs can cause large local variations in the heat transfer rate. A broad region of enhanced heat transfer between the vortices led to a substantial increase in the spanwise average heat transfer. Strong distortion of the normal two-dimensional boundary layer structure due to secondary flow was observed. Correlations relating integral boundary layer parameters to the local heat transfer rate were not accurate in the vicinity of a vortex. A strong correlation was found between the turbulence intensity near the wall and the local Stanton number even in regions of strong three-dimensional effects.

4205 Materials Testing

Refer also to citation(s) 21393, 21422, 21568, 21658, 21665, 21690, 21691, 21692, 21694, 21695, 21696, 21698, 21702, 21799, 21800, 21843, 21847, 22104, 22109, 22111, 22322, 22402

22278 (AD-A–214626/4/XAB) **Lubricated pipelining: Stability of core-annular flow. Part 2.** Hu, H.H.; Joseph, D.D. Minnesota Univ., Minneapolis, MN (USA). 1989. 39p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Fluid Mechanics, Vol. 205, 359-396(1989).

The author study the linearized stability of symmetric arrangements of two liquids in core-annular Poiseuille flow in round pipes. Deferring to one important application, they say oil and water when they mean more viscous and less viscous liquids. The 3 arrangements are: (1) oil is in the core and water on the wall; (2) water is in the core and oil is outside; and (3) three layers, oil inside and outside with water in between. The arrangement in (3) is our model for lubricated pipelining when the pipe walls are hydrophobic, and it has not been studied before. The arrangement in (2) was studied by Hickox (1971) who treated the problem as a perturbation of long waves, effectively suppressing surface tension and other essential effects which are necessary to explain the flows observed, say, in recent experiments of W. L. Olbricht and R. W. Aul. The arrangement in (1) was studied in part 1 of this paper. The authors have confirmed and extended their pseudo-spectral calculation by introducing a more efficient finite-element code. We calculated neutral curves, growth rates, maximum growth rate, wavenumbers for maximum growth and the various terms that enter into the analysis of the equation for evolution of the energy of a small disturbance. The energy analysis allows identification of the three competing mechanisms underway: interfacial tension, interfacial friction and Reynolds stress. Results are presented.

22279 (BMU–1989-228) **Studies on the controllability of sampling concepts for ultrasonic testing of welds in nuclear engineering.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Oppermann, W.; Feltkamp, K. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.). Sep 1988. 137p. (In German). Contract BMU SR 384. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

In manufacture, graded nondestructive tests are applied for the in-service testing of nuclear components (for example K2 components). The extent of these random sample tests have very generally been determined in working groups until now without considering quantitative statistical relations concerning quality control. In order to get additional information and decision aids for safety considerations, statistical testing concepts were analyzed and modified for the concerns of random sample ultrasonic tests. At first manufacture was given priority. The elaborated random sample concept which is based on an inspection by attributes (similar to DIN 40080) is practicable and technically adjustable. It was examined by real test results of welding seams. Compared to the present procedure the testing concept offers advantages especially with regard to the objective, quantitative estimation and control of quality and safety-relevant risks in random sample ultrasonic tests. The test expenditure and the effects on the safety of structural components can be calculated better. Possible ways are shown of how not only to register the contribution of the non-destructive testing to the quality assurance by random sample tests, but also to evaluate all quality-controlling measures as a whole. (orig./HP).

22280 (BMU–1989-229) **Studies on the controllability of sampling concepts for ultrasonic testing of welds in nuclear engineering.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Crostack, H.A.; Brueckner, K. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Dortmund Univ. (Germany, F.R.). Dec 1988. 48p. (In German). Contract BMU SR 385. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM

Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

With the introduction of convoy power stations random sample inspections are increasingly being applied to safety-relevant components. The extent of the tests and the selection of the components to be tested were largely determined very generally without considering the statistical inherent laws. In this context a conclusion, which can be estimated in its reliability, from the investigated partial sector to the interesting sampled universe is hardly possible at present. The investigations show that even for non-destructive tests of welding seams an analysis and an evaluation by means of the known mathematical-statistical methods is also basically possible. In consideration of the corresponding preconditions for random sampling as well as of the necessary marginal conditions the binomial distribution could be determined as a suitable sampling distribution. Thus the possibility is given to optimize the sample size under safety-relevant and economic viewpoints according to a mathematically defined proceeding. The data records available are, however, not sufficient to form a secure basis for carrying out an inspection by variables. The information on the display sizes can, however, successfully be used in the framework of double inspections by attributes with arbitrarily defined limits resp. multiple inspections by attributes. (orig./HP).

22281 (CONF-9004140–1) **A nonintrusive method for measuring the operating temperature of a solenoid-operated valve.** Kryter, R.C. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From Workshop on monitoring equipment environments during nuclear plant operation; Baltimore, MD (USA); 10-11 Apr 1990. Order Number DE90007576. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Experimental data are presented to show that the in-service operating temperature of a solenoid-operated valve (SOV) can be interred simply and nondisruptively by using the copper winding of the solenoid coil as a self-indicating, permanently available resistance thermometer. The principal merits of this approach include (a) there is no need for an add-on temperature sensor, (b) the true temperature of a critical — and likely the hottest — part of the SOV (namely, the electrical coil) is measured directly, (c) temperature readout can be provided at any location at which the SOV electrical lead wires are accessible (even though remote from the valve), (d) the SOV need not be disturbed (whether normally energized or deenergized) to measure its temperature in situ, and (e) the method is applicable to all types of SOVs, large and small, ac- and dc-powered. Laboratory tests comparing temperatures measured both by coil resistance and by a conventional thermometer placed in contact with the external surface of the potted solenoid coil indicate that temperature within the coil may be on the order of 40°C higher than that measured externally, a fact that is important to life-expectancy calculations made on the basis of Arrhenius theory. Field practicality is illustrated with temperature measurements made using this method on a SOV controlling the flow of refrigerant in a large chilled-water air-conditioning system. 5 refs., 7 figs.

22282 (FhG-IzfP–880335-TW) **Quality assurance in ceramic materials and components. High-resolution non-destructive testing especially of ceramic surfaces. Final report.** Reiter, H.; Hoffmann, B.; Morsch, A.; Arnold, W.; Schneider, E. Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Saarbruecken (Germany, F.R.). Inst. fuer Zerstoerungsfreie Pruefverfahren; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 18 Nov 1988. 97p. (In German). Contract BMFT 03 M 2003 0. Order Number DE90759068. Available from NTIS (US Sales Only), PC A05/MF A01.

This report discusses the influence of defects on the failure behavior of ceramic materials under four-point bending stress. In this connection various Si_3N_4 and SiC materials with and without artificially introduced defect particles (Fe, WC, Si, pores) were examined by the following non-destructive test methods: photoacoustic microscopy, scanning laser acoustic microscopy, microfocus roentgenoscopy and ultrasound transit-time measurements. Finally, a four-point bending test and a fracture-mechanical evaluation of the fracture-incuding defects were carried out at the Institute for reliability and failure studies in mechanical engineering of the University of Karlsruhe. According to the type of stress the samples predominantly failed in the case of defects in the surface zone of the side in tension. Among the ndt methods applied the photoacoustic microscopy as a typical surface testing method could predict most of the fracture-inducing defects (30-50 %) without causing destruction. In this connection a different detection sensitivity which corresponds to the thermal reflection factors became apparent according to the type of defect. Furthermore the reports describes the results of some preliminary tests on ndt of green ceramics. In these investigations both the microfocus roentgenoscopy test and the roentgen computed tomography showed a high potential of detecting inhomogeneities and defects in green Si_3N_4 and SiC components. (orig.).

22283 (FTC–2312C-1) **A description of preparations made to continue testing with an existing concrete abrasion test machine.** Comfort, G. Fleet Technology Ltd., Kanata, ON (Canada). Feb 1989. 34p. Contract EMR 15SQ.23440-7-9128. (MICROLOG–89-06219). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Concrete structues in ice-infested waters may experience damage due to ice abrasion and/or impact. In order to improve the evaluation of the resistance of concretes of interest to such abrasion and/or impact, a basic research program has been undertaken aimed at development of a test standard. A prototype test apparatus was built and some tests were conducted. In this report, continued work on the project is described with respect to modifications of the existing test apparatus and modifications to the data collection procedures. The apparatus basically consists of two rotating concrete cylinders in a tank, onto which an ice block can be lowered by a hydraulic ram. The existing data acquistion and machine control was modified for use with a Hewlett Packard 85B computer, which simplified machine control and provided greater flexibility. The existing means for profiling the concrete cylinders, hence for making wear measurements, was replaced by a system referenced to a zero baseline established on the cylinder itself, instead of on the frame of the apparatus. Some mechanical modifications were also made, including a closed-loop feedback control to provide precise temperature control of the water bath in the tank. 3 refs., 15 figs., 3 tabs.

22284 (OI–41-10986) **F.H.P. [flash hydrogen pyrolysis] repair: Final report.** Todd, I.A. Ortech International, Mississauga, ON (Canada). 6 Jul 1989. 6p. Contract EMR 89001-01-SQ. (MICROLOG–89-05389). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Continued processing problems were observed with the flash hydrogen pyrolysis unit of the Energy Research Laboratories (Canada Centre for Mineral and Energy Technology). A program was initiated to identify leak areas in the pressurized system, make repairs, and test the apparatus to ensure the operational quality of the equipment. Static and dynamic pressure tests were conducted, the latter at 1850 psi hydrogen. The operation of the unit was considered fully successful, demonstrating dynamic pressure control at the test pressure and flow control at levels from 10,000 to 21,000 liters per minute of hydrogen. Full furnace temperature control at 800° C, and reactor hydrogen preheat control at 25% allowable power, were demonstrated.

22285 (ORNL/ATD–20) **Cryogenic testing of fluoropolymer-coated stainless steel tubing.** Dooley, J.B. Oak Ridge National Lab., TN (USA). Nov 1989. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008022. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Stainless steel tubing coated internally with two different types of fluorinated polymers were subjected to microscopic examination after a welding operation had been performed on the tubing. The welded assemblies were photographed and subjected to repeated cycles between liquid helium and room temperature. The green

tetrafluoroethylene (TFE) coating peeled back in the area subjected to welding heat and displayed cracking all over its surface without regard to proximity to the weld area. The dark fluorinated ethylene propylene (FEP) coating showed a tendency to char or burn away progressively in the weld area. The dark (FEP) coating did not crack as extensively as the green TFE coating, but did show a few areas of "crazing" or cracking of the topmost surface after cryogenic exposure. 12 figs.

22286 (PB–90-130295/XAB) **Measurements of tribological behavior of advanced materials: Summary of US results on VAMAS (Versailles Advanced Materials and Standards) Round-Robin No. 2.** Ruff, A.W.; Jahanmir, S. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Tribiology Group. Sep 1989. 76p. (NISTIR–89/4170). Available from NTIS, PC A05/MF A01.

An interlaboratory comparison of tribological measurements was carried out among 16 U.S. laboratories as part of a large world effort involving six countries within the VAMAS (Versailles Advanced Materials and Standards) activity. Results for friction and wear of five material pairs are described in the report, along with a statistical analysis of the data, and interpretation of some of the findings.

22287 (PB–90-132739/XAB) **Institute for Materials Science and Engineering, Nondestructive Evaluation: technical activities, 1989. Annual report.** Yolken, H.T. National Inst. of Standards and Technology (IMSE), Gaithersburg, MD (USA). Nov 1989. 77p. (NISTIR–89/4147). Available from NTIS, PC A05/MF A01.

See also PB–89-151625.

A review of the Nondestructive Evaluation Program at NIST for fiscal year 1989 is presented in the annual report. Topics include the following: Intelligent processing of rapidly solidified metal powders; Nondestructive characterization of ceramic sintering; Monitoring of machined ceramic surfaces by thermal waves; Eddy-current temperature sensing; Ultrasonic sensor for sheet metal formability; Ultrasonic metrology for surface finish and part thickness; Measurement and control of polymer-processing parameters using fluorescence spectroscopy; Nondestructive evaluation of diamond films; Transient elastic waves in laminates; Intelligent processing of solder-joint connections for printed wiring assemblies; Ultrasonics and acoustic emission; Real-time x-ray radioscopy; Magnetic methods and standards for NDE; Eddy-current techniques; New standard test methods for characterizing performance of thermal-imaging systems; and Capacitive array research for characterization of ceramics.

22288 (PB–90-856923/XAB) **Tribology. June 1970-May 1985 (Citations from the NTIS data base). Report for June 1970-May 1985.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 185p. Available from NTISPC N01/MF N01.

See also PB–90-856931.

This bibliography contains citations concerning frictional and tribological behavior of such materials as thermoplastic and thermosetting plastics, ferrous and non-ferrous metals, and ceramics. Effects by environmental changes, extreme wear conditions, and corrosion are included. Theoretical and practical studies in adhesion, friction, wear, and lubrication are presented. (This updated bibliography contains 210 citations, none of which are new entries to the previous edition.)

22289 (PB–90-856931/XAB) **Tribology. June 1985-December 1989 (Citations from the NTIS data base). Report for June 1985-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 142p. Available from NTISPC N01/MF N01.

Supersedes PB–85-860609. See also PB–90-856923.

This bibliography contains citations concerning frictional and tribological behavior of such materials as thermoplastic and thermosetting plastics, ferrous and non-ferrous metals, and ceramics. Effects by environmental changes, extreme wear conditions, and corrosion are included. Theoretical and practical studies in adhesion, friction, wear, and lubrication are presented. (This updated bibliography contains 254 citations, all of which are new entries to the previous edition.)

4210 Combustion Systems

Refer also to citation(s) 21421, 21533, 21587, 21588, 22079, 22151

22290 (DOE/ER/80592–T2) **Development of a prototype pulse combustor sorbent treatment and injection SO_2 control technique: Quarterly technical progress report, October 1, 1989–December 31, 1989.** Kelly, J.; Pagaduan, N. Altex Technologies Corp., Santa Clara, CA (USA). Jan 1990. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-88ER80592. Order Number DE90007749. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the Phase II program is to develop and demonstrate a prototype of the Pulse Combustor Sorbent Treatment and Injection (PCSTI) concept under furnace conditions characteristic of full-scale utility boilers. In addition, an economic and engineering analysis of the system will be performed to assess its commercial potential. To achieve the program objective, several efforts are required including: prepare a PCSTI conceptual design; perform small-scale PCSTI tests to define optimal calcination parameters; upgrade and apply the sorbent capture computer model (SCCM) to assist data interpretation, system design and performance evaluation efforts; perform pilot-scale PCSTI furnace characterization tests to define optimal process parameters; utilize process data, pilot-scale furnace data and SCCM model predictions to define a high potential PCSTI prototype configuration; design, fabricate, and check out a prototype PCSTI system; perform prototype demonstration tests in a large-scale test furnace; compare direct sorbent injection and PCSTI system performance and capital and operating costs; evaluate the applicability of PCSTI system to a range of utility boilers; and define a high potential PCSTI system for commercialization. 8 refs., 16 figs.

22291 (OU/ME–89-06) **Turbulence measurements in the swirling flow at the entrance to the CCRL [Combustion and Carbonization Research Laboratory] tunnel furance facility.** Holloway, A.G.L. (Univ. of Ottawa, Ottawa, ON (Canada)); Tavoularis, S. Ottawa Univ., ON (Canada). Dept. of Mechanical Engineering. May 1989. 169p. Contract EMR 23440-8-9175/01-SS. (MICROLOG–89-05406). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The mean velocity (axial,radial and circumferential components) and turbulence stresses were measured at the burner exit, at the entrance of the Combustion and Carbonization Research Laboratory tunnel furnace (used to test various coal based fuels) for 3 fixed vane swirl generators and variable block type swirl generation; the measurements were made for various degress of swirl and mass flow rates. Turbulence length scales were also measured in some cases. It was found that, by orienting a cross-wire probe such that its axis would be roughly aligned with the mean flow direction, it is possible to measure all the mean velocity components and the dominant turbulent stresses in the swirling flow, and that, in the range of Reynolds numbers covered by the experiments, the mean velocity profiles and the turbulence stresses can be scaled by the mass flow rate. Typical estimates of the quantities used in simple turbulence models have been based upon the measurements and upon simplifying assumptious. The results of this study can serve as a guide in the evaluation and possible redesign of the swirl generators as well as assist the computational studies. 4 refs., 74figs., 57 tabs.

4220 Mining and Underground Engineering

Refer also to citation(s) 21301, 21378, 21392, 21393, 22795

22292 (PRM–CE02870, pp. 10) **Self propelled pipeline trencher for offshore Arctic application.** Carstens, D.K.; Thompson, E.J. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID,

Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The paper discusses the current development of a self propelled pipeline and cable trencher that has significant operational advantages for use in Arctic regions. The trencher utilizes water jets in order to cut a trench and also uses high pressure water for spoil removal and propulsion. Testing in the North Sea on pipeline risers has demonstrated that the trencher has cut a narrow trench to a depth of 3.5 m in a single pass. The trencher can operate up to riser elbow and can trench up to pipeline crossing with no danger of damaging the pipeline being crossed. In the Arctic it can be used for trenching from between an offshore platform up to and including the shore crossing. The trencher can be operated from any vessel; for example, a diving vessel could be utilized in deep water, and a shallow draft barge or pontoon for shallow water and beach crossing applications. The trencher is designed for use on any size of conduit from 1 in. telephone cable to 36 in. pipelines with burial depths ranging from 0.5 m to 6 m. In order to achieve deep trenches for sour protection of pipelines in ice infested waters, a multiple pass technique has been developed. The trencher weighs less than two tons in air and is neutrally buoyant in the sea. The trencher provides a simple trenching system capable of providing all necessary burial requirements for Arctic pipelines. It removes the need to use separate trenching systems for shallow and deep water areas and permits trenching of all pipeline sections, up to 40 miles in one summer season. 1 ref., 4 figs.

22293 (PRM–CE02870, pp. 24) **Canada and the ocean drilling program.** Robinson, P.T. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The Ocean Drilling Program, the successor to the former Deep Sea Drilling Project, is currently undertaking a long term study of the world's ocean basins in order to investigate such fundamental problems as the nature of crustal accretion and hydrothermal circulation on spreading ridges, the nature of basin formation and sedimentation on rifted continental margins, the evolution of global climates and the history of marine life. As a member of this program, Canada is assured of full scientific and technological participation. Participation is open to all Canadian geoscientists and opportunities include joining the ship for a specific drilling leg, studying core materials recovered by drilling, proposing specific drilling legs and sites, and serving on scientific advisory panels. During the next nine years, the ship JOIDES Resolution will drill in all of the oceans of the world. The size and stability of the ship make it possible to operate effectively under very adverse weather conditions, opening up new possibilities for drilling in high latitudes. In 1985, the ship drilled in the Norwegian Sea, the Labrador Sea and Baffin Bay, as well as at other locations in the Antarctic Ocean. In early 1987, she will operate in the Weddell Sea and other Antarctic waters before passing into the Indian Ocean. Drilling in the Labrador Sea and Baffin Bay has revealed high-frequency climatic oscillations recorded in the Plio-Pleistocene sediments, evidence of climatic deterioration and southward transport of Arctic waters beginning in the Middle Miocene, and evidence that subsidence in the Baffin Bay began about 60 million years ago. Ice rafting in the northwestern Atlantic apparently began about 2.5 million years ago. The success of this early drilling indicates that many similar problems of Arctic geology can be addressed in the future. 7 figs.

4230 Marine Engineering

Refer also to citation(s) 21292, 21293, 21295, 21296, 21307, 21361, 22125, 22292, 22293

22294 (CSR–90-01181) **Beaufort Sea Ice Scour Data Base (SCOURBASE), update to 1986.** Environmental studies research funds, Report no. 097. Gilbert, G.R.; DeLory, S.J.; Pederson, K.A. Canadian Seabed Research Ltd., Halifax, NS (Canada). 1989. 111p. (MICROLOG–90-01181). Available from PC Canada Oil and Gas Lands Administration, 355 River Road, 15th FLoor, Tower B, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The grounding of sea ice on high latitude continental shelves of the world represents a potential threat to the maintenance of subsea industrial installations. The Beaufort Sea SCOURBASE system was created to store the major scour parameters relevant to engineering design in a comprehensive data base format. The system was created, archived and interpreted using a microcomputer. An integrated sequence of in-house software processing utilities were written either in FORTRAN or the FOXBASE programming language. For interpretation, the Ice Scour Interpretation System (ISIS) was developed, including a number of data processing, binning and statistical and graphical utilities. A final software mapping system, GEOCAD, was written to digitally map track lines and scour parameters for interpretive and quality control operations. This report presents an update of the SCOURBASE system with additional high quality 1984-86 data sets, as well as the new NAVBASE system and the upgrading and improvement of the original Ice Scour Data Base. The report introduces the ECHOBASE system and the various details of the ECHOPRO data processing system responsible for building and controlling the quality of the various data sets. The main SCOURBASE system is described, including the parameters it stores, how they are measured and processed, and some of the results from different statistical analyses. The NAVBASE system, a digital navigation storage system, is also described and various parameters and NAVPRO data processing operations are documented. The report concludes by introducing a new data base, NEWBASE, for the storage of scours that are known to be recent and thus bear an associated indication of age. Recommendations for future ice scour research projects are also included. 2 figs., 5 tabs.

22295 (NOIA–89-05124, pp. 281-295) **Assessment of quality management systems.** Rytting, E. S. (EB Consultants A/S, (Norway)). Newfoundland Ocean Industries Association, St. John's, NF (Canada). 1989. (CONF-8906281–: Newfoundland offshore: project issues, St. John's (Canada), 6-8 Jun 1989; MICROLOG–89-05124). In *Proceedings of NOIA [Newfoundland Ocean Industries Association] conference '89.* Available from PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper describes the background and basic approach to the management of quality assurance in Norway in managing the construction of offshore rigs with special reference to experience gained in the Gullfaks A offshore project begun in 1981. The overall objective was to ensure both safety and cost efficiency in the platform development. The offshore rig operator and his management will always be responsible for the project success or failure. He must be part of the project team from the outset and will develop the control strategy for the project. Completion of an offshore project involves interaction with 20 - 25 contractors, 200 - 300 suppliers and a large number of subsuppliers and subcontractors. Problems arise when contractors fail to meet product specifications, delivery dates, costs estimates, safety standards or other project goals. Quality assurance management plans the coordination of contractor/supplier activities, analyzes project needs, ensures that contractors and suppliers fully understand project needs, and establishes clear objectives on product quality, safety standards, and delivery dates. Attention is given to accurately evaluating quality requirements so as to avoid costs incurred by setting more stringent quality objectives than are actually required. Experience has shown that costs incurred by establishing a quality assurance team are more than recovered by increased project efficiency. The best results are achieved when suppliers, contractors and operators understand and are in agreement with all relevant project guidelines. Suppliers and contractors are thoroughly assessed before contracts are let, and conformance is assessed by system and technical audits carried out by a team of specialists including a qualified systems auditor.

22296 (PRM–CE02870) **Arctic offshore technology conference and exposition.** Pallister Resource Management, Calgary, AB (Canada). 1986. 813p. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A conference on Arctic offshore technology was held to discuss operational concerns of interest to the oil and gas industry. Papers were presented in the fields of drilling, downhole and engineering considerations; construction and operation of offshore structures; economics of Arctic offshore exploration and development; subsea support systems; operations in marginal ice zones; the impact of ice and environment on production and operations; and offshore safety concerns. Separate abstracts have been prepared for 38 papers from this conference.

22297 (PRM–CE02870, pp. 22) **Ice/structure interaction research needs: A summary of workshops held in Calgary, 1986.** Zimmerman, T.; Adams, P. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

In May and June, 1986, a series of workshops, dealing with ice/structure interaction, were held in Calgary, Alberta. The workshops looked at the state-of-the-art of ice/structure interaction, identified gaps in the knowledge the currently exists in Canada, and made recommendations regarding research needs. The invited participants included many experts in the field. Objectives of current research are to develop and improve models, methods, and technologies required to define environmental design criteria; to improve techniques and technologies for offshore safety; and to provide the necessary engineering and related research and development for rigs and enable safe operations. The following areas were discussed in the workshop: global and local ice loads, including dynamic effects; physical modelling; rubble formation; monitoring and measuring systems; statistical and probabilistic aspects; and failure criteria and structural response for steel and concrete structures. This paper summarizes the highlights form the workshop discussions and the recommendations regarding research needs.

22298 (PRM–CE02870, pp. 12) **Molikpaq: The first move.** Greenidge, D. (Gulf Canada Corp., (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Molikpaq is a drilling platform owned and operated by Gulf Canada Corporation. In concept it is an ice strengthened, double hull, steel caisson capable of operating year round in the Beaufort Sea. In practice the caisson is much like a steel donut sitting on a prepared berm with a center filled with sand. Molikpaq is designed to be moved, as a single unit, to any drilling location in water depths of up to 40 m. This is an operation requiring careful planning and coordination of many special functions. September of 1985 was the first move from the Tarsiut location to the Amauligak location. Much time and effort was spent planning and coordinating the operation. A complete detailed manual was prepared setting out operations and guidelines. The worst summer ice season in the past several years greatly hampered the building of the berm, and delayed the start of the move for three weeks. Finally all was in place, the berm ready and the operation begun. A storm, reportedly the worst in the recorded weather history of the Beaufort Sea, occurred at one of the most critical points in the operation. However, Molikpaq was successfully moved to the new drilling location. The final accuracy at touchdown was within one meter of the desired location. 2 refs., 2 figs.

22299 (PRM–CE02870, pp. 43) **Construction and performance of a floating ice platform.** Masterson, D.M.; Pare, A.; Gamble, R.P.; Bourins, M. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The first floating ice platform built using sprayed ice was for the Panarctic Buckingham 0-68 well near Ellesmer Island in the Canadian Arctic during the 1983-84 season. Construction fo the ice platform commenced using free flooding techniques. However, the completion data for construction was estimated to be February 8, 1984, which was too late for the planned well. In order to speed up construction, 50-hp, 1400 kilopascal pressure submersible pumps which were being used on trail basis to build a relief well platform nearby using spraying, were moved to the main platform and used for its construction. This resulted in a saving of nine days of construction time. Ice build up rates were increased form 94 mm/d to 122 mm/d. The platform behaved well and both strength, and creep deflection met specified design conditions. The ratio of the ninety day deflection to the inial available freeboard was 0.56. The successful drilling of a well from this sprayed ice platform has led to the continued use for drilling of sprayed ice platforms in the Arctic Islands and sprayed ice islands in the Beaufort Sea. 18 refs., 16 figs., 5 tabs.

22300 (PRM–CE02870, pp. 5) **Icesemi: Computer software to analyse ice interaction with semi-submersibles.** Allyn, N.F.B.; Tseng, J.S.Q. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

As offshore activity proceeds in sub-arctic or marginal ice areas, the potential exists to extend the use of conventional semi-submersible drilling or production rigs to year-round use. A major development in the assessment of the ability of a moored semisubmersible to remain on station and resist forces from various ice conditions is the Ice semi computer software package for analyzing ice interaction with semisubmersible. This is compatible with IBM micro-computer format, and is very user friendly. Ice conditions in the sub-arctic areas can range from individual ice features driven by wind, wave and current, which can impact on the semi-submersible, to relatively steady state load conditions form pack ice. Icesemi has two main routines, one for each load condition. Icesemi can be used as a tool to rapidly evaluate the forces from various ice conditions, and so assess the ability of the semisubmersible to remain on station. This would prevent situations arising where drilling is suspended when, in fact, this may not be required, or vice versa. Alternatively, the software can be used to develop design criteria to evaluate the operating limits of existing or modified flotation systems under a range of ice conditions. The developed design criteria could also be used for new construction of harsh environment semisubmersibles. 1 fig.

22301 (PRM–CE02870, pp. 13) **Criteria for all-year drilling in northern Norwegian waters.** Tveter, L.; Aarrestad, L.P. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy,

Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A major study has been conducted with the objective of establishing a set of acceptance criteria to all-year exploratory drilling in Northern areas (north of 72 degrees) of the Norwegian continental shelf, an area where winter drilling so far has not been permitted. The study encompasses mobile drilling units, drilling systems, standby vessels, supply vessels, helicopter logistics, base facilities, contingency measures, pollution control, organisational matters and quality assurance. The study has been split into various phases, beginning with an extensive worldwide literature survey. An identification to the environmental conditions disclosed significant information on the polar lows, ice accretion, and the appearance of swell periods above 20 seconds. Based on this information, a considerable number of technical modifications and changes to operational procedures were proposed. These improvements were then evaluated concerning their contribution to risk, operational availability and costs in three separate studies. This then provided a basis from which realistic acceptance criteria can be established. Some of these criteria are listed in the areas of drilling equipment, surface vessels, pollution control, communication, evaluation, emergency backup, personnel, and quality assurance. 10 figs.

22302 (PRM–CE02870, pp. 14) **Artificial armour stone for Arctic application.** Thompson, E.J. (Univ. of Calgary, Calgary, AB (Canada)); Loov, R.E.; Gillot, J.E.; Shrive, N.G. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Offshore islands and structures require protection from wave and ice erosion. The mechanisms by which wave and ice encroachment are resisted are by their very nature conflicting. This protection has been traditionally provided by sandbags, concrete mats, or quarried rock. A new form of artificial armour stone, suitable for application in the offshore Arctic, has been developed in an Alberta research program. The scour protection investigated in this research programme is an artificial rock made from two ingredients: a sandy aggregate and non-marketable sulfur. Sand is available in cast quantities in the MacKenzie area and the sulfur many be obtained from the base pads of stockpiled sulfur located in Alberta. Laboratory testing has been undertaken on specimens manufactured from site specific aggregate obtained from three burrow sources in the Beaufort Sea. The laboratory tests and potential Arctic applications of the material are discussed in detail. The sulfur mortars produced were of satisfactory strength and samples made with Issigak gravel were comparable in abrasion resistance to portland cement concretes. An estimate of the cost of manufacturing a sulfur-based material in the Arctic from the site-specific materials studied indicates that, depending on transportation cost, the cost for 20,000 tonnes of sulfur based mortar would be $77-102 per installed tonne. 12 refs., 3 tabs. 12 refs., 3 tabs.

22303 (PRM–CE02870, pp. 14) **Construction and operational issues associated with production in the Canadian Beaufort Sea.** Lennox, M.V.; Hooper, M.W.; Al-Hashimi, W.M.; Pan, R.B. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Production development in the Canadian Beaufort Sea is based largely on existing worldwide offshore and Arctic drilling and production technology, together with some innovations, adaptations, and developments to suit Beaufort conditions. The developments associated with operations at water depths of 15-30 m are emphasized in this report. Important environmental features that influence production development technology include ice cover, water depth, remoteness from suppliers and markets, harsh winter climate, potential for ice scour of the seabed, presence of permafrost, and relatively poor seabed soil characteristics. Open water operations are limited by the short ice-free season which is further reduced by the limited marine access via either the Alaskan coast or the Northwest Passage. In most cases, marine operation in winter is impossible and this must be taken into account when planning emergency response operations and offshore platform resupply. The thick, relatively warm, layered permafrost extending 400-800 m down from a point 30-100 m below the seabed necessitates special measures to protect the permafrost zone around wells and minimize the effects of heat transfer. The use of subsea structures and equipment is being investigated as a means of overcoming the limitations of production from floating or bottom-founded structures. Subsea pipelines are also being considered as an alternative to tankers and/or barge systems. 2 figs.

22304 (PRM–CE02870, pp. 35) **The SSDC/MAT-construction and delivery.** Wichert, A.; Helmer, M. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

In June 1985, the Canmar/Reading & Bate Joint Venture (JV) entered into a two-year contract utilizing Canmar's single steel drilling caisson (SSDC) with a new base, the MAT, to drill in the Alaskan Beaufort Sea. The SSDC has a successful operating history in the Canadian Beaufort, where it was positioned on sands berms constructed by deep sea dredging ships to provide access to drillsites in deeper water. To avoid the necessity of dredging at each prospective drillsite, a steel MAT was constructed by JV to eliminate the need for dredged sand berms. Once joined together as a mobile offshore drilling unit, the SSDC/MAT drilling system will provide the opportunity for year round drilling in the Alaskan Beaufort Sea in water depths of 30-75 feet, without bottom preparation. The construction of the MAT and its subsequent joining to the SSDC posed many unique engineering and operational challenges. The MAT was fabricated in a shipyard in Japan to meet a schedule dictated by the Beaufort Sea weather window. The SSDC was modified in the Candian Arctic to permit joining of the SSDC and MAT systems. The two units were permanently mated offshore in the Alaskan Beaufort Sea prior to being installed on its first drilling location. This paper provides an overview of the MAT construction, SSDC modifications to permit mating, mobilization of the two units (the SSDC from Canada and the MAT from Japan) and their subsequent mating prior to drilling. 2 refs., 8 figs.

22305 (PRM–CE02870, pp. 24) **Physical modelling of operations in marginal ice zones.** Comfort, G. (Arctec Canada Ltd. (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

With the exploration of Canada's offshore regions, there has been interest in a number of ice environments, including marginal ice zones. A wide range of ice cover conditions may be found in these areas, including icebergs and large pans of relatively thin ice. In order to model operations in these ice conditions, it is necessary to duplicate the field ice failure modes and flow pattern of ice plates in the laboratory. This requires a model ice material which properly scales the macro-scale properties of natural ice, scaling laws which accurately reflect the key interactions, and testing techniques which accurately simulate the relative actions of ice movements, vessel or structure motions, currents or winds, as appropriate to the case being tested. Physical model testing may be used to meet several objectives. These include the development of design criteria and performance analysis, and the development

and/or simulation of operations in ice. These objectives are illustrated by examples from a wide range of model tests of operations in marginal ice zones, including the evaluation of multi-legged platforms, semi-submersibles, towing configurations and drillship protection methods. 8 refs., 14 figs., 2 tabs.

22306 (PRM–CE02870, pp. 9) **A diverless pipeline repair system using hyperbaric welding and remote vehicle.** Barrault, A.; MacFarlane, J. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A review was conducted of all aspects of underwater pipeline repair in order to define the objectives of a research program on a diverless repair system. The resulting objectives included development of a truly diverless system capable of operating to 500 m depth, which would use hyperbaric welding, a modular approach for the tooling, and a remotely controlled vehicle for deployment and actuation of the work modules. The main components of the system are: a tethered remote automated pipeline repairer (TRAPR), a pipeline handling frame, a pipe alignment frame, and a welding module. The 12-ton TRAPR vehicle is near completion and is the focus of this article. It is fitted with 4 ballast tanks sized so that up to 3 tons can be lifted without operating the thrusters. The propulsion system consists of 2 hydraulic power packs operating 12 thrusters, four each in the fore/aft, lateral, and vertical directions. The power packs also serve as energy source for tools and manipulators. Input/output computers at the surface and on the vehicle perform functions including telemetry, computations for autopilots and control, and graphic displays. The navigation system includes stereo television for good depth perception. A small 250-kg vehicle with its own telemetry, observation, and manipulator systems can be deployed from the TRAPR on a 50-m tether to provide supplementary observation and manipulation capability. The TRAPR itself is fitted with 2 manipulators, each with 7 functions. 1 fig.

22307 (PRM–CE02870, pp. 18) **Arctic drilling structure for the Beaufort Sea.** Cichanski, W.J. (Albam Engineers Inc., Seattle, WA (USA)); Jakobsen, B. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

An Arctic drilling structure designed for exploration drilling in the shear zone of the Chukchi and Beaufort Sea is described. The structure is viable for use in water depths between 18 m and 40 m, and is flexible in terms of being adaptable to a wide range of the soil conditions that are likely to be met in this area, ranging from dense sand to soft clay and silt. The structure is a monocone, using doubly curved shells of steel plate and concrete composite construction. The paper presents the design concept, construction plan, cost and schedule, and addresses the environmental conditions for which the structure is designed. Discussion of environmental loading focuses on interaction with ice. Design ice loads were derived from a limiting stress approach in which the ice feature interactions with the structure by riding up the conical part of the platform base and fails by bending. The structural design was based on finite element analysis run on two different structural models. Both serviceability limit state and ultimate limit state designs have been performed. The optimum design uses confined high-strength normal weight concrete, minimum thickness steel plates, and an overall wall thickness as required for the load. Geotechnical investigations of overall stability were also performed and indicated that all stability requirements are met by the design. 2 refs., 8 figs., 2 tabs.

22308 (PRM–CE02870, pp. 24) **Overview of operation environment interactions in marginal ice zones worldwide.** Bercha, F.G. (F.G. Bercha and Associates Ltd., Calgary, AB (Canada)). Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A general perspective is presented on principal problems resulting from operation-environment interactions in marginal ice zones worldwide. Marginal ice zones considered include those in the Labrador Sea, the Bering Sea, Sea of Okhotsk, the Barents Sea, and the Antarctic Seas. The operation types concentrate on current oil exploration, delineation activities, and future production facilities, although shipping and ice breaking problems are also considered. Following a review of principal ice characteristics including dynamics, first year ice properties, and icebergs, and a definition of other significant environmental interaction components such as water depth and storm intensities, the principal interaction scenarios for each of the marginal ice zones are considered. These scenarios include impacts of icebergs against fixed gravity-based structures in the Labrador Sea, compliant and floating structures in the Bering Sea, fixed production platform ice-structure interactions, and iceburg detection and avoidance in the Antarctic Seas. Principal problems requiring further attention are identified and recommendations for new programs are presented. 23 refs., 7 figs., 4 tabs.

22309 (PRM–CE02870, pp. 16) **Design considerations, field results, and approval considerations for offshore anti-icing systems.** Olsson, E.D. (Raychem Corp., Menlo Park, CA (USA)); Lonsdale, J.; Roecks, D. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Searching for oil in Arctic and subarctic waters requires significant precautions to minimize the effects that cold weather has on the operations of oil rigs and production platforms. One of the major problems of operating in this environment is the formation of ice. Ice formation can cause problems on helidecks, on emergency escape walkways, on doors, and in extreme cases ice formation on the superstructure and the bottom deck could threaten the stability of the rig. Considerable analysis has been done on the best methods of preventing the formation of ice on surfaces (anti-icing) and removing ice once it has formed on a surface (de-icing). The major techniques considered and used in practice are described. The major trade-offs that need to be considered when designing anti-icing systems are reviewed. These trade-offs generally involve installed cost and operating costs on one hand and operational convenience on the other hand. The Polar Pioneer rig was equipped with both anti-icing and de-icing systems. The performance of these systems on the Polar Pioneer during the winter of 1985 to 1986 and on numerous other rigs and supply ships is analyzed. The effects of wind blockage on the heat transfer coefficients and the total electrical load is discussed, as well as the approval requirements for de-icing and anti-icing systems for offshore rigs operating in various areas. 7 refs., 2 figs., 1 tab.

22310 (PRM–CE02870, pp. 30) **Spray ice formation, characteristics and adhesion to ship and structure coatings.** Sackinger, W.M. (Univ. of Alaska-Fairbanks, Fairbanks, AK (USA)); Feyk, C. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID,

Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Sea spray ice accretion on the superstructures of semi-submersibles, ships and service vessels can be very dangerous, and this phenomenon can occur every rapidly. The U.S. Department of Energy is sponsoring research which is focussed on the characterization of naturally-formed spray ice and the determination of the mechanical properties of the bond between sea spray ice and potentially useful coatings. The salinity, density and crystal structure of spray ice samples collected from two U.S. Coast Guard icebreaker cruises at the ice edge in March and October, 1985, and from a coastal location at St. Paul Island have shown that four categories of icing events can occur. The ice samples contained salinities ranging from 1 to 20 per thousand, and densities from 0.4 g/cm^3 to nearly 1.0 g/cm^3. The weather strongly influences the accumulation of natural sea spray ice accretion, and the four types of ice which can form. Tests of the shear strength of the spray ice and have produced various ranging from 29 kilopascals for Type 316 stainless steel to 4.4 kilopascals for polyethylene, with the icebreaker paint Inerta 160 giving a bond strength of 14 kilopascals. Some coating may lead to more rapid shedding of spray ice by gravity loading by the ice itself. 2 refs., 16 figs., 6 tabs.

22311 (PRM–CE02870, pp. 25) **Ice management for drilling activities of Canada's East Coast.** Nazarenko, D.M (ENTECH Resources, Calgary, AB (Canada)); Warbanski, G. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

The issue of ice management is fundamental concern to oil and gas exploration activities off the east coast of Canada because of the seasonal occurence of highly mobile sea ice and icebergs. The presence of ice in an environment characterized by frequent and severe storms presents problems unique to this region of offshore activity. Ice management programs currently in use on the Grand Banks incorporate aspects of ice monitoring and tracking, drift forecasting and implementation of some form of mitigative measures should the potential of ice impact with the drilling vessel arise. Considerabele effort has and is being expended in these areas to ensure that drilling activities may be conducted in a safe and efficient manner. Recent efforts have included the development and implementation of new techniques to improve detection, prediction and ice handling capabilities. A review is presented of current techniques for ice managenent in Canada's marginal ice zone, focusing on technology developed in recent year. Options are presented for future development efforts, such as the use of high pressure water cannons for deflecting iceburgs. 5 figs., 4 tabs

22312 (PRM–CE02870, pp. 15) **Project management of Beaufort Sea development.** Stenning, D.G. (AOE Consultants Ltd., Calgary, AB (Canada)); Smith, J.R. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

Arctic offshore projects pose several unique challenges to project management. As applied to the Beaufort Sea region, these include the limited open water season, the presence of ice floes, long mobilization times for marine equipment, lack of significant land based support in the immediate area, the right of essentially untrained local natives to take part in development projects, limited Canadian expertise, and technical considerations applicable to offshore operations in the Arctic environment. Methods are proposed for meeting these challenges within the framework of traditional project management techniques. A starting point is the recognition and acceptance of what cannot be managed, since Arctic projects are often frustrated by natural events beyond control. Another important factor is the use of personnel experienced with Arctic technology combined with those experienced in project management technology developed for major projects in other offshore regions such as the North Sea. Planning, cost control, and control of materials flows are essential elements, and are facilitated by use of computer systems which enable fast reaction to sudden changes. One of the most important items to be addressed early on in any development plan is the Arctic shore base requirements; in the Beaufort Sea, currently available facilities are limited and it is likely a new harbor will have to be developed to accommodate a major new project. Responsible quality control requires that the quality of a design, material, or piece of equipment is commensurate with its purpose. Management also needs a commitment to ensure that design criteria and philosophy adopted for the project take into account the uncertainty associated with the present state of technology. 2 figs.

22313 (PRM–CE02870, pp. 21) **Concrete gravity platform for the Bering Sea.** Knudsen, A. (Norwegian Contractors, Olso (Norway)); Jakobsen, B. Pallister Resource Management, Calgary, AB (Canada). 1986. (CONF-8610469–: Arctic offshore technology conference and exposition, Calgary (Canada), 28-31 Oct 1986; CE–02870). In *Arctic offshore technology conference and exposition.* Available from PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN.

A concrete gravity platform has been designed for the harsh environment of the southern Bering Sea. The environmental conditions there are similar to those in the North Sea, with the addition of drifting ice, and the soaked soil consists of very soft clay, similar to the normally consolidated clay in the Norweigan trench. The skirt piling foundation introduced with the Gullfaks C platform, now under construction in Norway, may thus be used. As a basis for the conceptual design, a Condeep type structure with 3 shafts or towers supporting the topside deck, and 19 caisson cells which form the base, has been selected. It is concluded that the well-proven North Sea concrete platforms, such as the Condeep platforms, are technically capable, with only minor modificatons, to resist forces of significant magnitude from drifting ice floes and ridges as found in the Bering Sea. Construction costs have also been estimated and a project schedule presented. 4 Refs., 9 Figs.

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Refer also to citation(s) 21619, 21915, 22036, 22127, 22157, 22172, 22184, 22186, 22239, 22261, 22269, 22456, 22473, 22481, 22486, 22973, 22974, 23100, 23153, 23175, 23179, 23192

22314 (AD-A–214638/9/XAB) **Laser action from a tetramethylpyrromethene BF_2 complex.** Pavlopoulos, T.G. Naval Ocean Systems Center, San Diego, CA (USA). 15 Dec 1988. 3p. Available from NTIS, PC A01/MF A01.

Pub. in Applied Optics, Vol. 2, No. 24, 4998-4999(15 Dec 1988).

The author reports on a continuing search for efficient and stable laser dyes. Our attention is focused on organic compounds which, besides exhibiting strong fluorescence (quantum fluorescence yield Phi(F) = 1), do not contain homocyclic and/or heterocyclic aromatic groups. This is an important attribute, since the syn-biamanes that show laser action possess high quantum fluorescence yields, and also have rather weak triplet-triplet (T-T) absorption bands in their fluorescence (laser action) spectral region. Because a pyrromethene-BF2-complex,4,4-difluoro-1,3,5,7-tetramethyl-4-bora-3a,4a-diaza-s-indacen (PMBF) has a Phi(F) = 0.80, this compound was synthesized and tested for its spectroscopic as well as laser action properties.

22315 (AD-A–214643/9/XAB) **Nonlinear optics technology. Phase 2. Area 1. Four-wave-mixing technology. Area 2. Phase conjugated solid state laser technology. Final report, September 1986-January 1988.** Brock, J.; Caponi, M.; Frantz, L.; Harpole, G.; Hoefer, C. TRW Space and Technology Group, Redondo Beach, CA (USA). 15 Jan 1988. 266p. Available from NTIS, PC A12/MF A02.

Four-wave-mixing (FWM) phase conjugation was investigated in materials that can operate at diode-laser wavelengths. Investigated were atomic cesium vapor, bulk GaAs, multiquantum well (MQW) GaAs/AlGaAs, and intracavity FWM in diode laser waveguides operating above threshold. Conjugate reflectivities up to 154% were observed in cesium for c-w pumping at about 100W/sq. cm, with signal observed over a 30-GHz bandwidth around the 852-nm hyperfine transitions. Self focusing and angular response were also investigated. Backward FWM phase conjugation at room temperature was demonstrated in bulk GaAs and MQW GaAs/AlGaAs for the first time. Reflectivities of about 0.1% were observed in both materials for 4 kW/sq.cm pumping. Results show that the stronger excitonic effects in MQW samples do not help FWM performance when high reflectivity (>10%) is desired because the pump fields required strongly saturate the excitonic component. Conjugate reflectivities > 2 million % were observed for FWM inside the waveguide cavity of diode lasers operating above threshold. The first demonstration of a conjugation capability in diode laser FWM, piston conjugation to correct optical path differences, was also accomplished. Detectivity of FWM was investigated to determine minimum input conditions. A ring oscillator, conjugated power amplifier was constructed and tested. Phase-conjugated doubling to produce high beam quality of the second harmonic when there are aberrations in the doubling medium was demonstrated and analyzed theoretically. Rapid turn-on of a solid-state laser was modeled to estimate thermal gradients and resulting optical distortion 2 s after start from a standby mode.

22316 (AD-A–214649/6/XAB) **Validation of model of external-cavity semiconductor laser and extrapolation from five-element to multielement fiber-coupled high-power laser.** Rediker, R.H.; Corcoran, C.; Pang, L.Y.; Liew, S.K. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Jun 1989. 8p. (JA–6201). Available from NTIS, PC A02/MF A01.

Pub. in IEEE Quantum Electronics, Vol. 25, No. 6, 1547-1552(Jun 1989).

The model used to explain the operation of an external cavity containing five discrete AR-coated semiconductor lasers and a spatial filter to assure coherent output from the cavity has been experimentally validated. This model predicts that the external cavity will operate as a coherent source with a multitude of discrete individual lasers and/or monolithic arrays. Control by an external cavity of the series combination of an optical fiber and an AR-coated semiconductor laser has previously been demonstrated. For systems requiring high average-power operation, distributed Ar-coated lasers that ar fiber coupled into an external cavity provide a potential alternative to broad-area lasers or monolithic laser arrays with high density of power dissipation which must use thermoelectric or other cooling. In comparing these approaches, system tradeoff should be made between the added complexity of the cooling system and the added complexity of the external cavity. An annular input to the external cavity from an array of fibers is proposed for high beam quality.

22317 (AD-A–214908/6/XAB) **Theoretical and experimental investigation of coupled Ar-ion lasers.** Jelonek, M.P. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). Oct 1989. 156p. (AFIT/DS/ENP–89-3). Available from NTIS, PC A08/MF A01.

A single-mode laser theory was applied to two coupled Ar-ion lasers in Fabry-Perot resonators, and the equations were solved numerically to predict intensity tuning curves and locking ranges for various types of mirror translations. The same theory was extended to model two modes in each cavity, which predicted a decrease in locking range as well as a mutually-reinforced hole-burning minimum. With a single, uncoupled two-mode He-Ne laser, the existence of the minimum was verified experimentally. Two multiline/multimode Ar-ion lasers were coupled through a common end mirror and the effect of coupling strength on phase locking was investigated by varying the reflectivity of that mirror. To mode coupling, interference fringe visibilities, output power, and the frequency and RF mode beat spectra were measured. The optimal phase locking occurred at about 25% coupling as determined by the maximum fringe visibilities produced by laser phase locking. That 25% coupling was the optimum coupling strength was also substantiated by fact that the maximum power output was also achieved at this point, and the appearance of the super cavity mode spacing verified that the behavior was due to phase locking. A passive cavity mode analysis of the three-mirror Fabry-Perot resonator showed the system oscillated on the composite resonator frequency as well as the frequencies of both sub-resonators.

22318 (AD-A–214928/4/XAB) **Cw ultraviolet laser excited with an electron beam. Final report, 1 July 1987-30 June 1989.** Rocca, J.J. Colorado State Univ., Fort Collins, CO (USA). Dept. of Electrical Engineering. Oct 1989. 59p. Available from NTIS, PC A04/MF A01.

Laser oscillation was obtained in the 318-nm transition of AgII. Excitation of the laser upper level occurs by charge-transfer collisions between ground state neon ions created by electron-beam ionization and silver atoms. CW laser oscillation was also obtained in the 478.8-nm line of AgII.

22319 (AD-A–215013/4/XAB) **Effects of pump modulation on a four-level laser amplifier.** Chakmakjian, S.H.; Koch, K.; Papademetriou, S.; Stroud, C.R. Jr. Rochester Univ., NY (USA). Inst. of Optics. 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Optical Society of America B, 1746-1751(1989).

A theory is developed to describe the way in which modulations in the pump intensity produce modulations in the gain of a four-level, homogeneously broadened laser amplifier. The theory is tested by carrying out an experiment using an alexandrite crystal pumped by a c-w dye laser. A second dye laser is used to measure the gain in the inverted laser transition. The dependence of the magnitude and the bandwidth of the gain on the pumping rate is determined. Agreement between theory and experiment is good.

22320 (AD-A–215022/5/XAB) **Quantum dynamics of chemical reactions. Final report, 1 July 1981-30 June 1982.** Kuppermann, A. California Inst. of Tech., Pasadena, CA (USA). Div. of Chemistry and Chemical Engineering. 11 Mar 1981. 17p. Available from NTIS, PC A03/MF A01.

The aim of the proposed research is the performance of quantum-mechanical calculations of an exact and approximate nature of the cross sections and rate constants of elementary chemical reactions. These calculations are of importance for the fundamental understanding of the nature of chemical reactions and for advanced technologies of interest to the United States Air Force, such as high-energy chemical lasers, plume technology, and the chemical effects of high-energy radiation. The calculations include processes involving three atoms, such as exchange reactions, collision-induced dissociation, three-body recombination, electronic branching ratios, tunneling, and vibrational quenching by reaction. The goal of this work is to develop a detailed understanding of such processes and to generate benchmark results which can serve as a basis for testing the validity of approximate methods.

22321 (CONF-9004138–2) **Implementation of a control system test environment in UNIX.** Brittain, C.R. (Oak Ridge National Lab., TN (USA)); Otaduy, P.J.; Rovere, L.A. Oak Ridge National Lab., TN (USA). [1990]. 20p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From 3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990. Order Number DE90007485. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses how UNIX features such as shared memory, remote procedure calls, and signalling have been used to implement a distributed computational environment ideal for the development and testing of digital control systems. The resulting environment -based on features commonly available in commercial workstations- is flexible, allows process simulation and controller development to proceed in parallel, and provides for testing and validation in a realistic environment. In addition, the use of shared memory to exchange data allows other tasks such as user interfaces and recorders to be added without affecting the process simulation or controllers. A library of functions is presented which provides a simple interface to using the features described. These functions can be used in either C or FORTRAN programs and have been tested on a network of Sun workstations and an ENCORE parallel computer. 6 refs., 2 figs.

22322 (GEPP-TIS–1168) **Nine-year aging behavior of the ceramic flatpack resonator.** Beetley, D.E. General Electric Co., Largo, FL (USA). Neutron Devices Dept. 6 Mar 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00656. Order Number DE90008044. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

GE has developed a multichannel, high precision aging- measurement facility capable of high volume testing of resonators. Features of the facility considered unique for production aging systems test include: (1) Loran-C/disciplined time-frequency (DTF) oscillator frequency standard, (2) direct current power bus design, (3) measurement and switching techniques, and (4) high volume automatic precision resonator aging. Computer-controlled data acquisition is used for unattended operation. Facility requirements included frequency measurement with sufficient precision to allow 20- year extrapolation of resonator frequency shift using 30 data points. The frequency reference is traceable to the National Institute of Standards and Technology (NIST). Long-term extrapolation required selection of a model which would most accurately reflect the major processes involved in aging. In order to verify the accuracy of model extrapolation, a group of resonators has been maintained in test for more than nine years. 9 refs., 16 figs.

22323 (IYaF–88-111) **ATsP8 analog-to-digital converter for potentiometric transducers.** Kargal'tsev, V.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1988. 14p. (In Russian). Order Number DE90620385. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

CAMAC-module analog-to-digital converter ATsP8 for potentiometer transducer maintenance is described. Recommendations on its application to control the position of electromechanical drives are presented. Computer input device of the joysteak type and the possibility of its application in systems of automatization of electrophysical installations is considered. 1 tab.

22324 (LA-UR–90-413) **Harmonic generation mechanisms in short-wavelength free-electron lasers.** Schmitt, M.J. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900140–13: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90007622. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The physical mechanisms that contribute to harmonic radiation in free-electron laser systems are examined. Mathematical models for the spontaneous and coherent-spontaneous emission in plane-polarized wigglers are given. How these models are used to perform numerical simulations is discussed. Modifications of the models to incorporate non-ideal free-electron laser effects are reviewed. 19 refs., 4 figs.

22325 (LRP–386/89) **Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.** Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. 28p. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Individual papers from this conference are indexed separately.

22326 (NIIEFA-P-G–0773) **Spatial gradiometer for direct current instability detection.** Doroshenko, V.N. Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR). 1988. 21p. (In Russian). Order Number DE90619019. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Problems on operation of superconducting transformer of flux (STF) under conditions of increased noise background are considered. Descriptions of structures of gradiometric transformers of flux are given. Volume gradiometric meter of instability of constant current, in which STF is applied as a reference element, is described in detail. Theoretical justification of operation principle is given, structural features and technical data are presented. 11 refs.; 15 figs.

22327 (PB–90-856709/XAB) **Acousto-optical laser modulators and deflectors. October 1987-December 1989 (Citations from the COMPENDEX data base). Report for October 1987-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 48p. Available from NTISPC N01/MF N01.

Supersedes PB–88-869243.

This bibliography contains citations concerning the theory, design, testing, performance, and applications of acousto-optical devices for laser beam modulation, deflection, splitting, mode locking, and tuning. Included in the cited reports are studies on acousto-optical materials. Applications of the interactions of acousto-optic devices on lasers include optical information processing, optical communications, optical memory devices, switches, scanners, and color-television display systems. (This updated bibliography contains 88 citations, 14 of which are new entries to the previous edition.)

22328 (PB–90-856725/XAB) **Indium-tin oxide films. January 1976-January 1990 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1976-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 175p. Available from NTISPC N01/MF N01.

Supersedes PB–87-864526.

This bibliography contains citations concerning fabrication techniques, properties, and applications of indium-tin oxide (ITO) films. Fabrication methods include sputtering, vapor and ion deposition, electron-beam evaporation, hydrolysis, and spraying. Studies of optical, electrical, and structural properties of ITO films are presented. ITO deposition on silicon and glass substrates, and their applications in solar energy conversion and window insulation are examined. (This updated bibliography contains 297 citations, 171 of which are new entries to the previous edition.)

22329 (SAND–89-1747) **Description, operation, and maintenance information on joystick and closed-circuit television MPS-36 radar, Meppen Range, Federal Republic of Germany: Technical manual.** Arndt, C.E. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008135. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Personnel from Stockpile Evaluation Program Division I, 7261, have been testing Joint Test Assemblies (JTAs) at Meppen Range, Federal Republic of Germany (FRG) since 1984. JTA trajectories were obtained from cinetheodolite film. The MPS-36 radar at Meppen Range is required to track the aircraft before bomb release to verify the release parameters for range safety and for the bomb trajectory after release. This is a difficult task because of the low-level approach of the aircraft. Division 7261 personnel asked Tonopah Test Range Department 7170 to assist in solving radar tracking problems. We recommended a new closed-circuit television system with a zoom lens and a force-operated, two-axis joystick. This system provides the operator a means of overriding the automode of the radar and manually positioning the radar antenna in azimuth (AZ) and elevation (EL). The joystick operator keeps the target (aircraft or bomb) centered in the TV picture by applying the correct pressure to the joystick. At the same time, the radar console operator maintains automatic range tracking by assisting the range gate through ground clutter using the control level of the range gate, as a rate-aid control in automatic mode. During the period May 8-17, 1989, the visual tracking equipment was installed in the Meppen radar. On May 16, 1989 a bomb dummy unit, loft maneuver was tracked successfully. The video, with time of day, was recorded for posttest, quick-look data. In the ten years of planned testing, a twenty-fold cost savings would be achieved with incorporation of the visual tracking capability to the MPS-36 radar, rather than providing radar beacons on each JTA. 8 figs.

22330 (SAND–89-2070C) **WARP-10: A numerical simulation model for the cylindrical reconnection launcher.** Widner, M.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004136–1: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr

1990). Order Number DE90007287. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A fully self-consistent computer simulation code called WARP-10, used for modelling the Reconnection Launcher, is described. WARP-10 has been compared with various experiments with good agreement for performance and heating. Simulations predict that it is possible to obtain nearly uniform acceleration with high efficiency and low armature heating. There does not appear to be an armature heating limit to velocity provided the armature mass can be sufficiently large. Simulation results are presented which show it is possible to obtain conditions needed for Earth-to-Orbit (ETO) launch applications (4.15 km/s and a 950 kg launch mass). This 3100-stage launcher has an efficiency of 47.2% and a final ohmic energy/kinetic energy = .000146. The mode of launcher operation is similar to a traveling water induction launcher and is produced by properly times and tuned discrete stages. Further optimization and much high velocities appear possible. 15 refs., 6 figs.

22331 (SAND–89-3025C) **Strategies for high efficiency operation of the E-beam excited atomic xenon laser using high-power and high-energy loading.** Ohwa, M. (Illinois Univ., Urbana, IL (USA). Dept. of Electrical and Computer Engineering); Kushner, M.J.; Peters, P.J.; Patterson, E.L.; Brannon, P.J. Sandia National Labs., Albuquerque, NM (USA). [1989]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900530–2: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90005196. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

E-beam excitation of the atomic xenon laser is theoretically and experimentally investigated using short-pulse high-power deposition (>MW/cm^3-atm) and low-power high-energy loading (≤1 kJ/ℓ-atm). Scaling laws are derived to maximize laser power and energy efficiency. 4 refs.

22332 (SAND–90-0231C) **The adaptive line enhancer applied to chirp detection.** Elliott, G.R.; Stearns, S.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005116–1: 1990 international symposium on circuits and systems, New Orleans, LA (USA), 1-3 May 1990). Order Number DE90006772. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses the ability of an adaptive line enhancer (ALE) driven by the least-mean-squares (LMS) algorithm to track the frequency of a chirping signal in broadband noise. The dynamic behavior of the weights is described and a weight tracking error bound is derived in terms in chirp rate. Frequency tracking and weight behavior are illustrated in examples. 6 refs., 7 figs.

22333 (UCRL–100480) **Systematics in positron annihilation lifetime analysis of high $T_c$superconducting transitions.** Howell, R.H. (Lawrence Livermore National Lab., CA (USA)); Radousky, H.B.; Wachs, A.L.; Fluss, M.J.; Turchi, P.E.A.; Jean, Y.C.; Sundar, C.S.; Chu, C.W.; Shelton, R.N.; Hinks, D.G. Lawrence Livermore National Lab., CA (USA). 23 Jun 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890718–35: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE90008361. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The lifetimes and momentum distributions of annihilating electron-positron pairs are changed in high Tc superconductors cooled below the superconducting transition. Since the initial observation of this phenomena in YBCO the observation of these effects has been reproduced and extended to other high $T_c$systems. There is a general consistency of results in most families of superconductors. An exception to this is YBCO which shows strong sample dependence. These consistent features have led to a model relating the pairing of the positive charge carriers and the positron distribution as one explanation for the lifetime changes. 8 refs., 1 fig.

22334 (UCRL–101479) **A progress report on the Livermore miniature vacuum tube project.** Orvis, W.J. (Lawrence Livermore National Lab., CA (USA)); Ciarlo, D.R.; McConaghy, C.F.; Yee, J.H.; Hee, E.; Hunt, C.; Trujillo, J. Lawrence Livermore National Lab., CA (USA). Sep 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891205–4: IEEE international electron devices meeting, Washington, DC (USA), 3-6 Dec 1989). Order Number DE90008302. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Using the sacrificial layer process, we are designing and building micron-sized vacuum diodes and triodes. The devices use silicon field emitters etched into the surface of a silicon wafer. The field emitters are then buried in layers of glass and conductive polysilicon to produce the grid and anode. The last step is to remove the glass layers, leaving the free standing anode and grid with 1 to 2 μm separations. Vacuum microelectronics are expected to be hard to more than 10^{17} neutrons/cm^2 and 10^8 Rad(Si) of gammas without sustaining permanent damage. Note that this is three to four orders of magnitude greater than the radiation levels that comparable silicon devices can withstand. Upset is expected to be on the order of 10^{11} Rad(Si)/s, compared to 10^8 Rad(Si)/s for silicon devices. Vacuum microelectronics should also be able to withstand in excess of 775 K, compared to a maximum of 650 K for the best silicon devices. Our current work involves enhancing the sharpness of the field emitters, so that they can operate at lower voltages. Recent applications of an oxidation sharpening method has created tips with a radius of curvature on the tip of less than 10 Å. 4 refs., 6 figs., 1 tab.

22335 (UCRL–102645) **Performance of zig-zag slab regenerative ring amplifier laser system.** Hackel, L.A. Lawrence Livermore National Lab., CA (USA). 13 Dec 1989. 2p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900530–4: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90006995. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report on a zig-zag slab laser system operated in a burst mode at 300W at 1.05 μm and 100 W at 0.53 μm. The laser was operated at pulse energies up to 20 Joules/pulse and 1GW peak power and repetition rates from 1 to 30 Hz. Output in continuous operation exceeded 50W at 1.05 μm and doubling efficiency of >32%.

22336 High power and solid state lasers II. SPIE - Volume 1040. Dubie, G. 203p. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

These proceedings discuss the papers on design and advancement of solid state lasers. Technology of optical pumping; semiconductor diode pumping; various laser materials efficiency and frequency control of lasers are the subjects covered here. Some applications of lasers in plasma fusion facilities are mentioned.

22337 Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H. (Physics International Co., San Leandro, CA (USA)); Turchi, P.J. 758p. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

These proceedings contain 181 papers grouped under the heading of: Switching 1-6; Insulation and breakdown; Accelerators and diodes 1-2; and Components and energy storage 1-2.

22338 Gas cooled slab scaling laws and representative designs. Albrecht, G.F. (Lawrence Livermore National Lab., Livermore, CA (USA)); Holtz, J.Z.; Sutton, S.B.; Krupke, W.F. pp. 203 of High power and solid state lasers II. Dubie, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

Based on simple considerations for the mechanisms limiting average power operation of solid state lasers, the authors deduce some scaling laws for the gas cooled disk amplifier architecture. They discuss geometrical issues, gain and efficiency considerations, and output power scaling. The paper in concludes an outline for a high repetition rate GSGG system and a very large average power module suitable for a fusion driver.

22339 Microlaminated ferromagnetic composites for magnetic switching. Wallace, J.L. (XI Magnetics, Inc., Coatesville, PA (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors have prepared samples of multilayer ferromagnetic composites by DC magnetron sputtering. Each sample consists of a large number of polycrystalline ferromagnetic layers interspersed with an equal number of insulating layers. The thickness of each ferromagnetic layer is chosen to be less than a skin depth in the VHF frequency range. Previous authors have predicted that such a structure should remain permeable to RF energy regardless of the total thickness since the laminated structure suppresses eddy current shielding and have verified the prediction for small signal levels. In the work presented in this paper, the authors have experimentally measured the response of our samples to large amplitude pulsed and CW signals to determine whether this class of material can be used as a high performance substitute for metallic glass in magnetic switching applications. They have produced energy in the VHF range (40 - 400 MHz) by driving samples with a 13.56 MHz sinusoidal H field in the easy axis direction.

22340 Optically enhanced electron attachment and its possible application in diffuse discharge switches. Pinnaduwage, L.A. (Oak Ridge National Lab., TN (USA). Health and Safety Research Div.); Christophorou, L.G.; Hunter, S.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC05-84OR21400. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Enhanced electron attachment due to electronically excited molecules produced by excimer laser light is reported. The authors discuss how this effect may be utilized to alter the conductivity of a diffuse gas discharge using nanosecond laser pulses and, thus, has possible application in high-power gas switches.

22341 High power induction free electron laser. Miller, J.L. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (USA)). pp. 203 of High power and solid state lasers II. Dubie, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The author discusses how free electron laser (FEL) amplifiers driven by linear induction accelerators have considerable potential for scaling to high average powers. The high electron beam currently produces large single pass gain and extraction efficiency, resulting in high peak power. The pulse repetition frequency scaling is limited primarily by accelerator and pulsed power technology.

22342 Nonlinear mode competition and coherence in low gain FEL oscillators. Antonsen, T.M. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research); Levush, B. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

One of the problems in the design of high power generators of coherent radiation is the competition of many eigenmodes of the resonator for the beam energy. A simple one dimensional, multi-mode model for a low gain FEL oscillator is used to study numerically the effect of mode competition on the coherency of the radiation. For the beam current smaller than four times minimum start-oscillation current many single mode states are possible. However, the time required to reach these states becomes very long for FEL devices described by a small slippage parameter. Two different time scales characterize the process of reaching a single mode state. The shorter time scale is related to an establishment of a relative constant amplitude of the radiation field, while the phase of the field is still modulated. The relaxation of the phase takes a much longer time. This process can be described analytically with a model which allows for investigation of the effects of noise and mode locking as the relaxation process. Results of both simulation and analysis are presented.

22343 X-ray laser gain optimization studies as function of Z and pump laser wavelength. Keane, C. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); London, R.; MacGowan, B.; Matthews, D.; Rosen, M.; Louis-Jacquet, M.; Bourgade, J.L.; Jacquemot, S.; Naccache, D. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). DOE Contract W-7405-ENG-48. (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 5A3.

The authors report measurements of the gain on the principle Ne-like 3p-3s transitions (J=2 to 1, J=1 to 1, and J=0 to 1) for Cu, Ge, Se, Sr and Mo ions. The variation of the gain function of pump laser wavelength and intensity is investigated. Both solid- and exploding foil type targets are used. The purpose of these Ne-like experiments is to vary plasma conditions in an attempt to maximize the gain and to investigate transitions such as the J=0 to 1 which have high predicted, but not observed gains. Results from the authors continuing investigation of the analog Ni-like 4d-4p lasing transitions are discussed.

22344 Failure modes of laminate structures. Gordon, L.B. (Auburn Univ., AL (USA). Space Power Inst.); Druce, R.L.; Wilson, M.J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract W-7405-ENG-48. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Laminate structures composed of alternating thin layers of conductor and dielectric material are commonly used in energy storage and transmission components. The authors report a study of the failure of the dielectric layers in regions of high field stress, with applied 60 Hz ac, dc and impulse voltages. Several geometries were compared, including staggered and flush edges. Electrical trees developed between the laminated dielectric layers. The visual characteristics and growth rates of the electrical trees under ac, dc and impulse stresses were different. Partial discharge detection and analysis was used to measure the inception voltage and discharge activity at the conductor edge voids, to observe tree formation and growth, and to predict impending failure due to dielectric erosion. Electric field distributions were modeled and partial discharge inception levels were estimated from known void geometries. The staggered edge geometry appears to enhance the electric field stress at the recessed electrode.

22345 Investigation of cryogenic photoconductive power switches. Goeller, R.M. (Los Alamos National Lab., NM (USA)); Thompson, M.C.; Hammond, R.B.; Lemons, R.A.; Nunnally, W. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report repetitive photoconductive power switching with a Nd:Yag laser at pulse rates up to 100 Hz demonstrated at room and cryogenic temperatures. A silicon rod 3 cm in length and 9 mm in diameter with a resistivity of 1 Kohm-cm was optically triggered in a circuit capable of allowing us to pulse charge the system or to bias the switch with constant voltage. In the pulse charge mode, an HY8 thyratron was used as a series switch to place a maximum of 1.25 J of stored energy in a 0.1 uf capacitor. This energy was then delivered to a 0.5 ohm load by optically triggering the photoconductive switch. In the direct current mode of operation, the triggering was performed with a constant voltage across the switch and load combination. These two arrangements made it possible to study the effect of thermal runaway in the PCPS at room and cryogenic temperatures.

22346 Toward pulsed power uses for photoconductive semiconductor switches: Closing switches. , Loubriel, G.M. (Sandia National Labs., Albuquerque, NM (USA)); O'Malley, M.W.; Zutavern, F.J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors present recent results on photoconductive semiconductor switches (PCSS) for Si and GaAs switches, they address surface flashover, contact degradation, and current limitations. For Si they have obtained samples that, without being triggered, withstand fields of up to 85 kV/cm produced by an –2-μs wide voltage pulse. The 1-inch diameter, Si samples (gap length of 1.5 cm) have been switched at 36 kV/cm ($\simeq$54 kV) into a –30-Ω load with a current of 703 A. For GaAs, most samples can withstand, without being triggered, 100 kV/cm. At low electric fields the GaAs samples behave as switches that close during the laser pulse and then open in nanoseconds. At high voltages GaAs does not open. In this mode, called lock-on, they have switched up to 42.7 kV/cm (64.1 kV). The lock-on mode can be triggered with small laser powers.

22347 Design and development of an improved AURORA Blumlein oil switch trigger system. Warren, F.T. (Physics International Co., San Leandro, CA (USA)); Frazier, G.B.; Simmons, D.P.; Seamen, J.F.; Turman, B.N.; Prestwich, K.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

An improved trigger system for the oil switches on the AURORA Blumleins has been designed and studied. The Pulserad 738 Machine has been temporarily disassembled and used to house a trigger system testing facility. The facility consists of a 2-MV Marx charging circuit, a Blumlein pulser and a replica of the AURORA oil switch, and has been used to test oil-switch triggering at the 4- to 6-MV level. The design details of this facility and the jitter performance of various components of the pulser are presented.

22348 Scaling relations for the rimfire multi-stage gas switch. Turman, B.N. (Sandia National Labs., Albuquerque, NM (USA)); Humphreys, D.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Analysis of several rimfire-type gas switch data sets between 2.4 and 5 MV allows the authors to develop scaling relationships for the switching mechanisms of multi-stage gas-insulated switches. Laser-triggering is emphasized in the reported study. The major conclusions of this study are presented.

22349 Optimum size of staged flux compression generators. Vorthman, J.E. (Los Alamos National Lab., NM (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

This paper presents the results of an investigation to determine when two small transformer-coupled flux compression generators are better than one large generator. The system considered consists of a helical flux compression generator transformer-coupled to an inductive load. The question is then whether the system energy gain (final load energy divided by initial system energy) would be greater if the generator were split in half and a transformer used to connect the pieces. For the lossless case, this problem has been solved exactly in terms of the transformer k factor and the initial and final generator inductances. An approximate solution which assumes a simple loss model is also discussed.

22350 A high-voltage multistage laser-triggered gas switch. Denison, G.J. (Sandia National Labs., Albuquerque, NM (USA)); Corley, J.P.; Johnson, D.L.; Weber, G.J.; Hamil, R.A.; Crowder, G.W.; Alexander, J.A.; Petmecky, D.A.; Schanwald, L.P.; Ramirez, J.J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

This paper describes the development and testing of an SF_6-insulated, multistage laser-triggered gas switch for use in the Hermes-III accelerator. Twenty of these switches are used in Hermes III to transfer energy from intermediate energy storage water-dielectric capacitors to the pulse-forming lines (PFLs) and to provide the overall synchronization of the accelerator. The gas switches operate in an oil environment. The gas switches operate in an oil environment, are charged to a peak voltage between 2.2 MV and 2.4 MV in – 1 μs, and are laser triggered with a root-mean-square (rms) jitter equal to or less than 2 ns. Both the triggered and untriggered performance of the switch have been investigated. A summary of the development tests are presented together with initial results from Hermes III.

22351 Recent developments in opening photoconductive semiconductor switches. Zutavern, F.J. (Sandia National Labs., Albuquerque, NM (USA)); Loubriel, G.M.; O'Malley, M.W. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report on their development of high power photoconductive semiconductor switches (PCSS) for opening and closing (toggling) applications. They have recorded fast opening times and what appears to be the onset of non-destructive electron avalanching. Using 1 and 2-inch diameter wafers of GaAs, Cr:GaAs, and Au:Si, they have switched a 50-ohm, 80-ns transmission line at voltages up to 65 kV. In the dark, the GaAs switches will stand-off dc fields up to 30 kV/cm in SF_6. Upon optical triggering the behavior depends on the average electric field. Below 4 kV/cm (8 kV/cm doped) they open with a 20-ns (< 3 ns doped) exponential recovery time. When the light is removed above these fields, the switches lock on, conducting whatever current the circuit will supply and stabilizing to 4 kV/cm (8 kV/cm doped) across the switch.

22352 Investigations into the design of multi-terawatt magnetic switches. Harjes, H.C. (Sandia National Labs., Albuquerque, NM (USA)); Penn, K.J.; Mann, G.A.; Neau, E.L. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Magnetic switches were successfully used for pulse compression in the Comet II pulsed power module to deliver 2.7 MW and 3.7 TW to a 2 Ω matched load. However, the Comet switches suffered interwinding dielectric breakdowns and failed in < 100 shots. Initial results from experiments on magnetic switch core insulations indicate that the insulation scheme used in the Comet switches was not optimal and better configurations exist. The Comet magnetic switch failures have been duplicated and studied on the magnetic switch test module (MSTM), a coaxial, 2 Ω PFL driven by a 600 kV Marx generator. The results of these experiments are discussed in detail.

22353 Laser trigger system for the Hermes-III accelerator. Hamil, R.A. (Sandia National Labs., Albuquerque, NM (USA)); Woolston, T.L.; Ramirez, J.J.; Schanwald, L.P.; Clark, B.F.; Corley, J.P.; Johnson, D.L.; Cowen, P.J. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The laser trigger system for the twenty, 2.2-MV rimfire switches in the Hermes-III accelerator is being installed and tested. The

laser is a modified commercially available 0.9-J KrF laser whose output is divided into twenty beams. Each beam is optically delayed for the purpose of proper switch timing and is then directed to the SF_6 insulated high voltage gas switch. The alignment system provides a convenient, reliable, low-cost method of aligning the KrF laser beam with the twenty switches. The optical system, consisting of seventy individual components, is environmentally protected and mounted on rigid structures to assure the alignment. In addition to design information, preliminary triggering test data are discussed.

22354 Prospects for x-ray amplification with charge-displacement self-channeling. Solem, J.C. (Los Alamos National Lab., NM (USA). Theoretical Div.); Luk, T.S.; Boyer, K.; Rhodes, C.K. *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics (USA)*, 25(12): 2423-2430 (Dec 1989).

The authors develop an analytic theory of charge-displacement self-channeling: a mechanism that can dynamically trap a short intense pulse of light. They focus on the case of most interest for X-ray amplification: the strongly saturated channel, for which all free electrons are expelled from the channel core and the channel walls are overdense. Some results are: the intensity at the channel walls is independent of the total laser power, the radius of the channel increases very slowly with laser power, asymptotically as the fourth root, and the power in the channel wall is a constant. The channel is energetically stable in the sense that a bifurcation will cause a net increase in the electrostatic potential energy, but is only marginally stable against relativistic filamentation in the walls. They also find that the channel is an effective waveguide for all secondary radiation.

22355 High-quality tunnel-junction devices using high-T(c) superconductors. Soulen, R.J.; Wolf, S.A. To Department of the Navy, Washington, DC. USA Patent Application 7-373,555. 30 Jun 1989. 14p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This invention relates generally to superconducting devices and, specifically, to tunnel junctions and Josephson junctions in superconducting devices. A structure and method for fabricating tunnel junctions from high transition-temperature material are disclosed. A tunnel junction consists of three films successively deposited on a substrate: a superconductor, an insulator or normal metal and a superconducting or normal metal. The critical interface is between the superconductor and the insulator or normal metal. Previous attempts to form tunnel junctions have used the upper surface of the superconductor which is invariably rough and inhomogeneous. This invention uses the lower surface which is more epitaxial to fabricate tunnel junctions and Josephson junctions.

22356 Apparatus for the efficient wavelength conversion of laser radiation. Chun, M.K.; Goldberg, L.; Weller, J.F. To Department of the Navy, Washington, DC. USA Patent Application 7-370,965. 26 Jun 1989. 19p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

An apparatus for generating coherent radiation at a desired frequency is disclosed. In a preferred embodiment the apparatus comprises: an injection-locked semiconductor diode structure having a large active area for emitting a diffraction-limited beam at a preselected frequency; optics for focusing the diffraction-limited beam into a focused beam; a nonlinear crystal responsive to the focused beam for producing a beam of laser power which includes an output beam at a desired harmonic of the preselected frequency; and a device for passing the output beam in a given direction. In a modification of the preferred embodiment, the output of the injection-locked semiconductor diode structure is mixed with an emission from a laser source in the nonlinear crystal to produce a desired sum or difference frequency.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 22880, 22883

22357 A new design of the University of Manitoba cyclotron for D^- ion acceleration and a study for the beam extraction from the Princeton University AVF cyclotron. Huang, Yunxiang. Thesis (Ph. D.). vp.Univ. of Manitoba, Winnipeg (CA) (1988). Available from National Library of Canada, Ottawa.

Two independent cyclotron upgrading projects are treated separately: a redesign of the University of Manitoba cyclotron for D- ion acceleration and a study of the beam extraction from the Princeton University AVF cyclotron. These two projects are described in part 1 and part 2 of this thesis, respectively. The first part includes the analysis of the magnetic field mapping data that was previously obtained from the University of Manitoba cyclotron, as well as systematic beam orbit dynamics studies, based on the improved magnetic field and the newly designed central dee-tips for the D- ion acceleration. These studies showed that after the upgrade program is finished, it will be possible to obtain in the University of Manitoba cyclotron a D- ion beam with substantial improvements in the available maximum energy, beam quality and transmission efficiency. The second part of this thesis first describes the extensive modifications that are made in the computer program that was previously used. The modified program can now be used over the full energy ranger of an AVF cyclotron. Then the upgraded computer code is utilized to carry simulative calculation for the reference particle and the beam in the phase space, from the ion source until after passage through the electro-static deflector of the Princeton University AVF cyclotron. On the basis of these studies, all the many parameters for the extraction system were optimized, and suggestions for further improvements are proposed.

4301 Design, Development, and Operation

Refer also to citation(s) 22357, 22420, 22882, 23055, 23133, 23171, 23180

22358 (CRN-VIV–55/2) **Origin of the voltage breakdowns in electrostatic particle accelerators.** Haas, F. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. Jun 1988. 6p. (CONF-880687–: 13. international symposium on discharges and electrical insulation in vacuum, Paris (France), 27-30 Jun 1988). Order Number DE90756414. Available from NTIS (US Sales Only), PC A02/MF A01.

The electromagnetic radiation flux has been measured near the tank wall of the Strasbourg MP Tandem as a function of the terminal voltage. The observed rapid flux increase is probably correlated with discharge phenomena occurring inside the accelerator tube and near its entrance. A lower level of radiation corresponding to the critical regime of total voltage breakdowns has been established.

22359 (LBL–27603) **The ALS [Advanced Light Source]: A third generation light source.** Robinson, A.L.; Schlachter, A.S. Lawrence Berkeley Lab., CA (USA). Sep 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890802–23: 7. synchrotron radiation instrumentation (SRI) national conference, Berkeley, CA (USA), 6-10 Aug 1989). Order Number DE90007780. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Advanced Light Source, a third-generation national synchrotron-radiation facility now under construction at the Lawrence Berkeley Laboratory, is scheduled to begin serving qualified users across a broad spectrum of research areas in April 1993. Based on a low- emittance electron storage ring optimized to operate at 1.5 GeV, the ALS will have 11 long straight sections available for insertion devices (undulators and wigglers). Undulators will generate high- brightness soft x-ray and ultraviolet (XUV) radiation; wigglers will extend the spectrum generated into the hard x-ray region, but at a lower brightness. Up to 48 bending-magnet ports will also be available. Engineering design has begun on a complement of three undulators with periods of 8.0, 5.0, and 3.9 cm that between them will cover the photon-energy range from 5.4 eV to 2.5 keV when the first, third, and fifth harmonics are used, as well as a wiggler with a critical energy of 3.1 keV. Undulator beam lines will be based on high-resolution spherical-grating monochromators. A Call for Proposals has been issued for those who wish to participate in the design, development, commissioning,

and operation of the initial complement of ALS experimental facilities (insertion devices, beam lines, and experimental stations) as members of a participating research team. The deadline for receipt of proposals was August 15, 1989. Proposals are expected to reflect the Letters of Interest received from potential PRTs during the previous year. 6 refs., 4 figs., 5 tabs.

22360 (N–90-14084) **Use of a krypton isotope for rapid ion changeover at the Lawrence Berkeley Laboratory 88-inch cyclotron.** Soli, G.A.; Nichols, D.K. Jet Propulsion Lab., Pasadena, CA (USA). Sep 1989. 9p. (NASA-CR–186107;JPL-PUBL–89-28;NAS–1.26:186107). Available from NTIS, PC A02/MF A01.

An isotope of krypton, Kr86, has been combined with a mix of Ar, Ne, and N ions at the electron cyclotron resonance (ECR) source, at the Lawrence Berkeley Laboratory cyclotron, to provide rapid ion changeover in Single Event Phenomena (SEP) testing. The new technique has been proved out successfully by a recent Jet Propulsion Laboratory (JPL) test in which it was found that there was no measurable contamination from other isotopes.

22361 (RAL–89-101) **The application of system identification techniques to an R.F. Cavity tuning loop.** Mestha, L.K. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 67p. Order Number DE90620091. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

System identification is the terminology used for the process of characterising a given control system. A mathematical representation of the frequency response characteristic is obtained to utilise all the known design techniques to arrange the feed-back loop to meet required control performance criterion. This is known as parametric system identification. The intention of this paper is to speed up the process of identifying the R.F. Cavity tuning system of the 800 MeV accelerator, ISIS. While achieving this goal the computer must not disturb noticeably the normal function set out by the system. This task of automatic characterisation is necessary so that a self-adapting feed-back loop can be arranged to adjust itself without human interference and meet severe R.F. tuning requirements on ISIS. In any case the results of parametric identifications are useful in designing a robust feed-back loop with appropriate gain and phase margins. The approach using a Pseudo Random Signal is currently practised in Process Industries. (author).

22362 (SLAC-PUB–5190) **Prospects for next-generation e^+e^- linear colliders.** Ruth, R.D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8907134–6: 17. SLAC summer institute: physics at the 100 GeV mass scale, Stanford, CA (USA), 10-21 Jul 1989). Order Number DE90008101. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of this paper is to review progress in the US towards a next generation linear collider. During 1988, there were three workshops held on linear colliders: "Physics of Linear Colliders," in Capri, Italy, June 14–18, 1988; Snowmass 88 (Linear Collider subsection) June 27–July 15, 1988; and SLAC International Workshop on Next Generation Linear Colliders, November 28–December 9, 1988. In this paper, I focus on reviewing the issues and progress on a next generation linear collider. The energy range is dictated by physics with a mass reach well beyond LEP, although somewhat short of SSC. The luminosity is that required to obtain 10^3–10^4 units of R_0 per year. The length is consistent with a site on Stanford land with collision occurring on the SLAC site; the power was determined by economic considerations. Finally, the technology as limited by the desire to have a next generation linear collider by the next century. 37 refs., 3 figs., 6 tabs.

22363 **RF power for the next linear collider.** Herrmannsfeldt, W.B. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

It is generally agreed that the next linear collider (NLC) will be conventional in the sense that it will consist of a disk-loaded waveguide using microwave rf power. It will almost certainly be unconventional in requiring unprecedented amounts of power at a higher frequency than has been used previously for such applications. This paper reviews the approaches that have been considered and/or are still under consideration as rf power sources. There are two general categories: systems that use rf pulse compression and systems that directly generate and use the large peak power needed to drive a section of an accelerator.

22364 **Dynamic behavior of IREB in a collective ion acceleration experiment.** Fine, T.A. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research); Rhee, M.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report an experimental study of dynamic behavior of net current in conjunction with collective ion acceleration. In the presence of neutral gas, either puffed in or released from the anode foil, the IREB injected is subject to the charge and current neutralizations, resulting in a complicated time and space dependent beam distribution in the drift tube. To investigate the dynamic behavior of the current in the drift tube, typically a 0.5 MeV, 70 kA, 100 ns electron beam of 2.54 cm diam is injected through a foil anode into a drift tube of 15 cm diam. Reproducibility of experiment was improved by using a specially designed anode system with a foil changer which allowed the production of many shots of high current electron beam without disturbing the vacuum condition. The net currents were measured by a Rogowski coil built in the anode system, and a movable Faraday cup along the drift tube. The ions accelerated were diagnosed mainly by a Thomson spectrometer system placed at the end of the drift tube.

22365 **RADLAC-II module accelerator development for double pulse injector operation.** Jones, E.E. (Sandia National Labs., Albuquerque, NM (USA)); Smith, D.L.; Mazarakis, M.G.; Jojola, J.M.; Hasti, D.E.; Lehmann, M.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The RADLAC-II Module (RIIM) accelerator has been converted to a double-pulse accelerator with a foil-less diode injector load. The diode/injector performance has been addressed in the double-pulse operation mode using two machine configurations to compare two voltage regimes. In both cases, a gas phenomenon appears to inhibit the generation of a second electron beam. The higher voltage single-pulse mode injector configuration produces a 20-30 kA, 4 MV, 40 ns electron beam. The primary areas discussed in this paper include: first pulse coupling and interference with the second pulse water switches, second pulse water switch jitter, additional losses of the second pulse, and injector plasma shorting between pulses for separations less than 2 ms.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 22341, 22364, 23160, 23161, 23170, 23173, 23214

22366 (DOE/ER/10569–T5) **Collective ion acceleration in high current relativistic electron beams: Annual report.** Nation, J.A. Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies. [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-80ER10569. Order Number DE90008328. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report describes the progress made during the current contract period investigating the use of high power relativistic electron beams for electron and ion acceleration. Section 2 gives a summary of results from the relativistic klystron experiment and details our plans for a large diameter coaxial system. Section 3 summarizes our efforts to generate upper hybrid waves on relativistic electron beams. Simulation work of the upper hybrid excitation process is

reported. Our experiment using high power microwaves for electron acceleration is discussed. This paper also reports progress on development of repetitive pulsed experimental and data acquisition systems. Our future research plans are outlined, followed by a list of publications and presentations from our present work. 10 figs.

22367 (IFVE-OLU–88-214) **Modification of the method of equivalent chrages in the electrostatic Robin's problem.** Barsukov, A.B.; Surenskij, A.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 11p. (In Russian). Order Number DE90620098. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

High-frequency quadrupole focusing 4-wave accelerating structures are used in linear accelerators with low-energy protons and heavy ions. Application of the equivalent charge method for solution of electrostatic three-dimensional problems is described. The variational case of this method is considered in Roben's problem. The exact proof of this version which allows to shorten the calculations is given. Some formulas for charge positions with optimal places of equivalent sources are given. The numerical examples of calculating the characteristics of the accelerating structure with high-frequency quadrupole focusing are given. 10 refs.; 5 figs.

22368 (INIS-SU–154) **Theory of a periodic cylindrical waveguide with a nonuniform metal-dielectric filling.** Kazanskij, V.B.; Kotsarevskaya, I.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Radioastronomicheskij Inst. 1988. 56p. (In Russian). Order Number DE90620099. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Prerint no.15.

A theory of wave propagation through a screened annular waveguide with a piecewise-continuous fieling is developed. The coupled fields in the dielectric layers are described with the aid of a characteristic matrix. The conditions at the discrete boundary yield a set of fucntional equations characteristics of the Riemann-Hilbert problem. The propagation constant follows from the condition that the determinantal of the equivalent algebraic set should be equal to zero. Analysis of the field phase and reduced amplitude in a wide range of variation of the waveguide parameters suggests promising performance characteristics of the structure as a prototype mode and spatial spectrum selector. 18 refs.; 22 figs.

22369 (JAERI-M–89-173) **Basic design for the synchrotron in the Large Synchrotron Radiation Facility, (2).** Nakayama, Koichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Kobasawa, Mitsuaki; Shimada, Taihei; Yokomizo, Hideaki; Harami, Taikan. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 32p. (In Japanese). Order Number DE90759895. Available from NTIS (US Sales Only), PC A03/MF A01.

We have investigated the dynamic behavior of the longitudinal and transverse beam emittance during acceleration for the 8-GeV synchrotron in the Large Synchrotron Radiation Facility. We have compared the 1-Hz synchrotron with the 10-Hz one. In this report, we have discussed the effect of eddy current during acceleration and the beam dynamic behavior with beam instability. (author).

22370 (LBL–27676) **Study of collective effects for the APIARY collider.** Zisman, M.S. Lawrence Berkeley Lab., CA (USA). Sep 1989. 33p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8906210–5: Workshop on B-factories and related physics issues, Blois (France), 26 Jun - 1 jul 1989). Order Number DE90008493. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The design of a high-luminosity electron-positron collider to study B-physics is a challenging task from many points of view. In this paper we consider the influence of collective effects on the machine performance; most of our findings are "generic," in the sense that they depend rather weakly on the details of the machine design. Based upon an example machine design (APIARY-II), we investigate single-bunch thresholds for the longitudinal microwave and transverse mode-coupling instabilities, examine the possibility of emittance growth from intrabeam scattering, calculate the beam lifetime from Touschek scattering and gas scattering, and estimate the growth rates for both longitudinal and transverse coupled-bunch instabilities. We find that the single-bunch instabilities should not lead to difficulty, and that the emittance growth is essentially negligible. At a background gas pressure of 10 nTorr, beam lifetimes of only a few hours are expected, which will place a burden on the injection system if a high average luminosity is to be maintained. Even this lifetime is likely to require an innovative design for the vacuum system to maintain a pressure of 10 nTorr in the presence of a circulating electron or positron beam of approximately 1 A. With a standard PEP-like multicell rf system, multibunch growth rates are very severe, especially in the longitudinal plane. There appear to be significant benefits to a radically different rf system design, either utilizing superconducting single-cell rf cavities, or cavities with equivalent geometrical shapes but operated at room temperature. Even then, a powerful feedback system will likely be required. Nonetheless, it does not appear that there are any fundamental problems that stand in the way of successfully designing and building such a high-luminosity B-Factory. 13 refs., 9 figs., 5 tabs.

22371 (LBL–28029) **The Beam Break-Up Numerical Simulator.** Travish, G.A. Lawrence Berkeley Lab., CA (USA). Nov 1989. 62p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008052. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Beam Break-Up (BBU) is a severe constraint in accelerator design, limiting beam current and quality. The control of BBU has become the focus of much research in the design of the next generation collider, recirculating and linear induction accelerators and advanced accelerators. Determining the effect on BBU of modifications to cavities, the focusing elements or the beam is frequently beyond the ability of current analytic models. A computer code was written to address this problem. The Beam Break-Up Numerical Simulator (BBUNS) was designed to numerically solve for beam break-up (BBU) due to an arbitrary transverse wakefield. BBUNS was developed to be as user friendly as possible on the Cray computer series. The user is able to control all aspects of input and output by using a single command file. In addition, the wakefield is specified by the user and read in as a table. The program can model energy variations along and within the beam, focusing magnetic field profiles can be specified, and the graphical output can be tailored. In this note we discuss BBUNS, its structure and application. Included are detailed instructions, examples and a sample session of BBUNS. This program is available for distribution. 50 refs., 18 figs., 5 tabs.

22372 (LBL–28114) **Radioactive beam production at the Bevalac.** Alonso, J.R.; Feinberg, B.; Kalnins, J.G.; Krebs, G.F.; McMahan, M.A.; Tanihata, I. Lawrence Berkeley Lab., CA (USA). Oct 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891044–7: 1. international conference on radioactive nuclear beams, Berkeley, CA (USA), 16-18 Oct 1989). Order Number DE90007774. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

At the Bevalac radioactive beams are routinely produced by the fragmentation process. The effectiveness of this process with respect to the secondary beam's emittance, intensity and energy spread depends critically on the nuclear reaction kinematics and the magnitude of the incident beam energy. When this beam energy significantly exceeds the energies of the nuclear reaction process, many of the qualities of the incident beam can be passed on to the secondary beam. Factors affecting secondary beam quality are discussed along with techniques for isolating and purifying a specific reaction product. The on-going radioactive beam program at the Bevalac is used as an example with applications, present performance and plans for the future. 6 refs., 6 figs., 1 tab.

22373 **High current proton beams in multi-stage linear induction accelerators.** Golkowski, C. (Cornell Univ., Ithaca, NY (USA)); Kerslick, G.S.; Nation, J.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A 1 MV, 6kA, 50 nsec annular proton beam is generated in a full cusp geometry diode and transported along a 0.6 T solenoidal

magnetic field. The radial profile and transport efficiency are measured under different drift tube conditions using carbon activation. Faraday cup arrays give time resolved measurements of the net and ion current densities. Their measurements show that successful transport can be achieved by using a fast puff valve to fill the drift region immediately downstream of the full cusp with neutral gas. Results are presented demonstrating beam transport efficiencies of 99% and maintenance of the annular beam profile throughout the drift region. The implications of these results for the development of multi-stage induction accelerators are considered.

22374 The Argonne advanced photon source. Moncton, D.E. (Argonne National Lab., Argonne, IL (US)). pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Argonne National Laboratory is preparing to build a new synchrotron radiation source, the 7-GeV advanced photon source (APS), that will provide x-ray beams for research. The APS, reported in this paper, will produce x-rays for materials research, condensed-matter physics, chemistry, and biological and medical studies by researchers from industry, universities and national laboratories. Currently the APS project has entered the detailed design phase necessary to begin construction in October 1990 and operations in 1995. As shown, in this paper, this synchrotron x-ray facility will include a 40-period, 7 GeV positron storage ring containing 34 five-meter insertion device locations and a similar number of bending magnet ports.

4303 Auxiliaries and Components

Refer also to citation(s) 21570, 22337, 22353, 22366, 23158, 23161, 23162, 23164, 23168, 23170, 23182, 23190

22375 (BNL–43877) **Status of the BNL cold atomic beam and its focusing magnets.** Hershcovitch, A.; Kponou, A.; DeVito, B. Brookhaven National Lab., Upton, NY (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900289–3: International workshop on the polarized ion sources and polarized gas jets, Tsukuba-Shi (Japan), 12-17 Feb 1990). Order Number DE90008513. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Since the last workshop in Montana, Switzerland, output of the BNL cold atomic beam has improved by more than an order of magnitude to a flux of over 10^{20} H^0/sr/s. Spin selection and focusing by three different magnets: a superconducting solenoid lens, a long permanent magnet sextupole, and a system consisting of two short permanent and electromagnet sextupoles, have been tried. Results indicate that the latter scheme is best for our particular needs. 6 refs., 1 fig., 1 tab.

22376 (BNL–43878) **Recent developments in the BNL intense polarized H^- source program.** Kponou, A.; Hershcovitch, A.; Alessi, J.G.; DeVito, B.; Meitzler, C.R. Brookhaven National Lab., Upton, NY (USA). [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008524. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A program to develop a high intensity polarized H^- ion beam for injection into the AGS is under way at this laboratory. The approach we are following is essentially the polarization and ionization of a very cold and intense atomic hydrogen beam. This paper reports on the magnetic focusing of the cold atomic hydrogen beam we have produced. 4 refs., 4 figs.

22377 (BNL–43880) **The BNL volume H^- ion source.** Prelec, K. Brookhaven National Lab., Upton, NY (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891055–14: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90008510. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper is a progress report on the studies of the BNL volume H^- ion source. We have measured the H^- yield, $I_H{}^-$, and the ratio $I_e/I_H{}^-$ as function of the size of the extraction aperture, strength of the conical filter field, size and position of the filament, and of the phase of the filament heating current. The H^- current density in the extraction aperture was lower for the largest aperture, while there was a broad maximum when the conical field varied. Position of the filament and the phase of the filament heating current are very important parameters. 5 refs., 10 figs., 1 tab.

22378 (BNL–43913) **Present status of BNL polarized sources.** Alessi, J.G.; DeVito, B.; Hershcovitch, A.; Kponou, A.; Meitzler, C.R. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900289–2: International workshop on the polarized ion sources and polarized gas jets, Tsukuba-Shi (Japan), 12-17 Feb 1990). Order Number DE90008523. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A review is given of the BNL polarized source development occurring since the 1986 Workshop in Montana, Switzerland. The polarized source in operation for the AGS produces ≈40 μA of $\vec{H}^-$ with 75–80% polarization. Development of a cold atomic beam for a higher intensity source has concentrated on studies of spin selection and focusing with both a superconducting solenoid and sextupoles. Ionization of H^0 by D^- charge exchange using the ring magnetron ionizer seems to be hindered by gas scattering, and work is in progress to improve this.

22379 (BNL–43939) **Polarized beams at the ZGS and the AGS.** Ratner, L.G. Brookhaven National Lab., Upton, NY (USA). [1989]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8910344–2: Kent M. Terwilliger Memorial symposium, Ann Arbor, MI (USA), 13 Oct 1989). Order Number DE90008522. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

I have had, and still do, a feeling of deja Vu as I have gone through the development of the polarized beam at the AGS. There were many similarities both scientifically and sociologically, and of course, some significant differences between the AGS and the ZGS. We traded the 12 GeV ZGS for the 28 GeV AGS, we traded Ron Martin for Derek Lowenstein, but having the lowest energy, high energy machine did not change. Paraphrasing some remarks of Bob Sachs, the AGS replaced the ZGS as the tail of the dog, and it appears that now the tail loppers are again on the loose. You will probably see them again somewhere in the world using body english to help polarize a beam. Basically, I would like to describe a little of the progression of events and the hardware in both accelerators that allowed Kent and his colleagues to do a great deal of very interesting spin physics. 6 refs., 30 figs.

22380 (CONF-891043–3) **Initial use of the positive-ion injector of ATLAS.** Bollinger, L.M.; Billquist, P.J.; Bogaty, J.M.; Clifft, B.E.; Den Hartog, P.K.; Munson, F.H. Jr.; Pardo, R.C.; Shepard, K.W.; Zinkann, G.P. Argonne National Lab., IL (USA). [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From SNEAP '89: symposium on northeastern accelerator personnel; Oak Ridge, TN (USA); 22-27 Oct 1989. Order Number DE90007794. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The positive-ion injector of ATLAS consists of an ECR heavy-ion source coupled to a 12-MV superconducting injector linac. The ECR source and a 3-MV version of the partially completed linac have been used to accelerate successfully several species of heavy ions. The operating experience is summarized, with emphasis on the excellent beam quality of beams from the new injector. Two new fast-timing detectors are described. 9 refs., 5 figs., 1 tab.

22381 (DOE/ER/60858–T1) **X ray microimaging by diffractive techniques: Progress report.** State Univ. of New York, Albany, NY (USA). Research Foundation. [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60858. Order Number DE90008444. Available from NTIS, PC A02/MF A01 - OSTI.

The first year of the research program resulted in significant progress on several fronts. We had a rapid start, because the soft x-ray undulator beamline, X1A, at the National Synchrotron Light Source became operational shortly before the start of the grant

period. In microimaging by diffraction, Dr. David Sayre was successful in recording moderately large angle diffraction patterns from single diatom specimens. The patterns (Fig. 1) correspond to information down to the 70 Angstrom level, and are by far the best achieved to date. To obtain these, a new diffraction camera was constructed and commissioned. It features a multiple pinhole collimator to define a 10 micron diameter beam, and an alignment system to position the 2 micron specimen within it. 2 figs.

22382 (IFVE-OKU–88-207) **On studying and modifying the active filter of the U-70 ring electromagnet.** Lapin, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 26p. (In Russian). Order Number DE90620105. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The active filter of the U-70 electromagnet with one output transformer is shown to have stop band limitations caused by wave properties of the magnet. It is proposed to make some alternations of the filter using the available strong-current equipment which allows one to overcome the limitations mentioned above. The electromagnet parameters have been clarified. 19 refs.; 10 figs.; 3 tabs.

22383 (IFVE-OP–88-187) **Possibilities of optical transition radiation using for the U-70 and the UNR proton beam diagnostics.** Borovkov, S.D.; Grishenkov, S.A.; Novikov, V.P.; Serga, E.V.; Kharlamov, A.V.; Khodyrev, Yu.S. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 23p. (In Russian). Order Number DE90620110. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experimental results for optical transition radiation (OTR) of 70 GeV protons have been obtained. A possibility of the proton beam diagnostics using this raiation and the digital television method is illustrated. It is shown that thin aluminium fail doesn't perturb the proton beam and the conditions for using OTR for beam monitoring improve with proton energy. 15 refs.; 14 figs.; 1 tab.

22384 (IFVE-ORI-ONF–88-220) **Electromagnetic calorimeter on the base of cylindrical tubes with liquid krypton Monte Carlo simulation.** Lanev, A.V.; Fedyakin, N.N.; Shuvalov, R.S. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 17p. (In Russian). Order Number DE90620111. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Monte Carlo calculations of energy and spatial resolution of calorimeter made up of ionization tubes 1 cm in diameter have been performed. The obtained results are coordinate resolution equals to 0.8, 0.2 and 0.1 mm for 0.1, 1 and 10 GeV photons respectively, energy resolution equals 6.3, 2.7 and 1.8% for electrons of the same energy. 13 refs.; 4 figs.; 1 tab.

22385 (IFVE-ORI-OP-ONF–88-206) **Muon radiation fields at the UNK neutrino channel.** Ammosov, V.V.; Rzaev, R.A.; Uzunya, A.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 18p. (In Russian). Order Number DE90620106. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results on calculating muon fields along the UNK neutrino channel are presented. Basic recombination for shields against muon radiation have been formulated. It is shown that the earth bank of 10 m in thick is necessary to provide radiation protection of a neutrino channel over a tunnel of decay base. Acceptable muon background in a neutrino beam with a wide spectrum can be provided by combinated protection steel (>or approx. 250 m+bank (≈1200m)), active protection (magnetic toroids) and the presence of air interval (≈600 m) between the end of muon protection and a a neutrino detector. It is possible to use a steel absorber (≈ 550m) or uranium one (≈ 140 m) for experiments on a direct neutrino beam and a neutrino beam with a narrow energy spectrum, where maximum acceptnace of a monitoring facility is necessary. 9 refs.; 11 figs.

22386 (IFVE-OUNK–88-218) **Influence of interlayers seams on the superconducting winding temperature regime.** Zlobin, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij); Kozub, S.S.; Merinov, I.G.; Kharitonov, V.S.; Shako, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 14p. (In Russian). Order Number DE90620107. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The influence of the increased heat releases in the interlayer seams of the superconducting winding of the UNK dipoles of various designs on their working efficiency has been analyzed. The influence of the seams cooling and its position on the winding temperature margin has been studied. The heating of the dipole winding with the cold iron under the influence of the a.c. losses in the winding and iron, and static heat load to the helium vessel through the support and heat radiation has been calculated. 1 refs.; 6 figs.; 3 tabs.

22387 (IFVE-OUNK–89-1) **Method for calculation of longitudinal and transverse coupling impedance of periodic structures in accelerators.** Kurennoj, S.S.; Purtov, S.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 16p. (In Russian). Order Number DE90620112. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The main problem of beam intensity limitation in modern accelerators and storage rings is the various types of instabilities. The method for calculation of a coupling impedance of periodic structures with quite general boundaries is developed. This technique is applicable at any frequencies and for arbitrary beam energy. It is especially convenient for short-period structures. To illustrate method potentialities longitudinal and transverse impedance of cyclic accelerator corrugated chamber in resonance region and at low frequencies for various beam energies are calculated. The comparison with results obtained by other methods in the regions of their applicability shows good agreement. 21 refs.; 6 figs.

22388 (IFVE-OUNK–89-23) **Development of the methods and means of precise forming and geometry control of superconducting current-carrying element for the UNR pulsed dipoles.** Borisov, E.P.; Surkov, A.N.; Taran, N.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 13p. (In Russian). Order Number DE90620108. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to "Ehlektrotekhnicheskoe proizvodstvo".

Control features and methods for obtaining precise-accurate trapezoidal cross sections in superconducting stranded cables are described. Devices for control and molding provide the output of stranded cables of the value with mean-square deviation from the size along the middle line of a trapezoid equalling 3 μm. 3 refs.; 11 figs.

22389 (IFVE-OUNK–89-24) **Heat leak measurements in superconducting dipole magnet supports.** Kozub, S.S.; Shpakovich, Ya.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 9p. (In Russian). Order Number DE90620109. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The methods and results of measuring heat leak in the UNK, superconducting (SC) dipole magnet with a warm magnetic shield are described. Proceeding from the thermal conduction of the materials used for fabrication of the SP magnet supports, the measured values for the heat leak in the supports and outlined the ways of its reduction are analyzed. 4 refs.; 6 figs.

22390 (INIS-SU–158/A) **Destruction of quasiperiodic oscillations in weakly nonlinear oscillators.** Belogortsev, A.B.; Vavriv, D.M.; Tret'yakov, O.A.; Chernyshov, I.Yu. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Radioastronomicheskij Inst. 1989. 30p. (In Russian). Order Number DE90620113. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Preprint no.25.

The results of theoretical and experimental investigations of conditions and scenarios of chaotic oscillation occurrence in active nonautomonotonous oscillators with weak nonlinearity are presented. The theoretical analysis is based on application of averaged equations. A classical resonance generator of radio-frequency

range has been chosen to carry out experimental investigations. The results obtained permit to revise some representations about dynamic properties of such oscillations. General laws of quasiperiodical oscillation destruction connected with bifurcations of two- and three-dimensional torri are studied. The role of nonisochronous features of oscillators when forming their chaotic dynamic is explained. The possibility of occurrence of dynamical chaos in the weakly nonlinear isochronous van der Pole oscillator is proved.

22391 (INS–777) **Liquid-^{4}He target with a small refrigerator.** Kato, S.; Kitami, T.; Maruyama, K.; Murata, Y.; Endo, S.; Niki, K.; Morita, T. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Oct 1989. 16p. Order Number DE90759899. Available from NTIS (US Sales Only), PC A03/MF A01.

A liquid-^{4}He target system with a small refrigerator has been developed for the first time to study γ^4He reactions at intermediate energies. The density of the target is controlled within an accuracy of 3 %. The target system has been operated successfully for more than 1,000 hours of the experiment using the π-sr TAGX spectrometer at the 1.3-GeV Tokyo electron synchrotron. (author).

22392 (INS-T–490) **CAMAC memory module: MEMO-32.** Ikeda, Masaru. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Sep 1989. 16p. (In Japanese). Order Number DE90759846. Available from NTIS (US Sales Only), PC A03/MF A01.

For high-speed data transfer from the CAMAC front-end electronics to an on-line computer, two types of CAMAC memory modules (MEMO-32 and MEMO-32Q) have been developed. These modules snoop the data on the CAMAC dataway and write them on a memory by one CAMAC command; F(0). This feature reduces the number of CAMAC actions for data acquisition. With these modules, even an inexpensive system consisting of a personal computer and an auxiliary Crate Controller can handle a large amount of data in high speed. The modules have been used for experiments with the large acceptance spectrometer, TAGX, at the 1.3-GeV ES. (author).

22393 (IPNO-T–86-06) **Experimental study on the magnetized discharge sources (PIG type) for the multicharged ions production.** Depauw, J. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Dec 1986. 135p. (In French). Order Number DE90756355. Available from NTIS (US Sales Only), PC A07/MF A01.

The physical phenomena controlling the performance of a source of ions, applying magnetized discharges, is studied. The ions source is formed by three electrodes placed in a homogeneous magnetic field. The electron beam injection is effectuated by means of an indirectly heated cathode. The anti-cathode is placed in front of the cathode, at a potential (value) equal to that of the electron's source. The determination of the mass and charge of the extracted ions is performed by the magnetic analysis, at 180 degrees, of the ions current. The influence of the different macroscopic parameters, such as heating, arc potential, arc current, pressure, gas flow in the source, is described. The inner lowest residual pressure is estimated to be about 10^{-5} torr. The improvement in high charge yields is obtained by using gas mixtures (Kr with Ne or Ar). The characteristics of the discharges are given. Parameters such as the metal sublimation energy, the influence of the ion mass in the metal target sputtering, the atoms time delay in the plasma, and the charge exchange process are considered. It is shown that the discharge equilibrium can be analyzed in the same way as that for a binary mixture.

22394 (IYaF–89-50) **System for programmable microtreatment by a focused ion beam.** Dubrovin, A.N.; Dudnikov, V.G.; Kovalevskij, D.V.; Shabalin, A.L. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 19p. (In Russian). Order Number DE90620104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A system for programmable microtreatment of articles by a focused ion beam is developed. A contrast treatment of 0.1 μm wide line is obtained. High luminosity ion beams are generated by electrohydrodynamical source and a shaped by electrostatic ion-optical column with astigmatism correction and the beam deflection by an octupole deflector. Stabilized electric power supply of all system elements and automatic control of microtreatment in CAMAC standard on-line with Odrenok computer is provided for. Features of programmable microtreatment and observation of its results in raster ion microscopic regime are considered. 11 refs.; 14 figs.

22395 (NIKHEF-K-AmPS–89-03) **Modification of MEA modulator-klystron units enabling short pulse injection into a pulse-stretcher ring.** Kroes, F.B.; Heine, E. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). 1989. 15p. (CONF-890335–: 13. particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE90706052. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In order to modify the present 500 MeV, 1% duty factor electron accelerator MEA into a 900 MeV, 0.1% d.f. injector for a newly to be build pulse-stretching ring, the present modulator-klystron units have to be adapted from 4 MW, 2% d.f. mode of operation into the 10 MW, 0.2% d.f. mode. Suitable klystrons are commercially available, the matching modulators, however, will be obtained by modifying the present ones, which policy is dictated by economical considerations. The design principles of these modulators -a prototype is presently under construction- will be discussed. Special attention is given to the video-pulse shape requirements, dictated by the future performance of the pulse-stretcher. This device has to deliver low emittance, high duty factor (n90%) beams for nuclear physics experiments. Some proto-type tests of the video-pulse forming modifications will be presented. 5 refs., 11 figs., 2 tabs.

22396 (RAL–89-112) **The tasks of tracking and vertex location at future hadron colliders.** Saxon, D.H. Rutherford Appleton Lab., Chilton (UK). Oct 1989. 16p. (CONF-8909107–: ECFA study week on instrumentation technology for high luminosity hadron colliders, Barcelona (Spain), 14-21 Sep 1989). Order Number DE90620114. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The role of tracking and vertex location in triggering, event isolation and reconstruction is reviewed. Event characteristics are briefly outlined and the requirements for lepton and hadron tracking with and without magnetic fields are set out. Experimental techniques are outlined, including those for working close to the vertex. Handling of overlapped events places limits on the complexity of physics that can be studied as a function of luminosity. (author).

22397 (SLAC-CN–374) **Sector 30 collimator radiation.** Namito, Y. (Ship Research Inst., Tokyo (Japan)); Nelson, W.R.; Benson, E. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 22 Feb 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90008768. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The collimators at Sector 30 of the SLAC accelerator are designed to scrape off a significant fraction (e.g., ~20%) of the SLC beam. The electromagnetic cascade shower that develops in the collimator, and in the scraper and waveguide downbeam, leads to very high radiation exposures of TV cameras (and other devices) located nearby. The collimator (point) source accounts for one-third of the dose and is best shielded by extending the radius of the copper scraper. Radiation from the waveguide accounts for the remaining two-thirds of the dose, and is difficult to shield since it is a line source. However, the spectrum from the waveguide is expected to be softer than that from the collimator. This paper discusses shielding of these sources.

22398 (SLAC-PUB–5129) **Improving reliability in the SLC [Stanford Linear Collider] control system.** Heinen, N.; Spencer, N.; Tinsman, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Oct 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-891094–16: International conference on accelerator and large experimental physics control systems, Vancouver (Canada), 30 Oct - 3 nov 1989). Order Number DE90008012. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

During the past year, considerable emphasis has been placed on improving the overall reliability of the SLC control system. The Errorlog Facility has proven a useful tool to diagnose hardware and software problems. By analyzing the various error messages and

their correlations, one can usually determine the software component or hardware module causing faults. Daily summaries help to identify problems so that they can be remedied before they become catastrophic; thereby bringing about a considerable increase in performance. We discuss the various tools we use and our operational experience with them. 3 refs., 6 figs.

22399 (SLAC-PUB-5187) **Exploiting VM/XA.** Boeheim, C. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9003103-1: SHARE '74 conference, Anaheim, CA (USA), 4-9 Mar 1990). Order Number DE90008010. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Stanford Linear Accelerator Center has recently completed a conversion to IBM's VM/XA SP Release 2 operating system. The primary physics application had been constrained by the previous 16 megabyte memory limit. Work is underway to enable this application to exploit the new features of VM/XA. This paper presents a brief tutorial on how to convert an application to exploit VM/XA and discusses some of the SLAC experiences in doing so. 13 figs.

22400 (UCID-21935) **Thin Si_3N_4 windows for MeV ions.** Lefevre, H.W. (Oregon Univ., Eugene, OR (USA). Dept. of Physics); Schofield, R.M.S.; Ciarlo, D.R. Lawrence Livermore National Lab., CA (USA). 3 Jan 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008092. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report here the results of studies on (nominal) Si_3N_4 ultrathin windows for bringing MeV protons out of vacuum into ambient air with small scattering. The windows were made by anisotropic etching of Si to expose about a square millimeter of silicon nitride film integrally attached to a silicon frame. Three sets of windows of different thicknesses were tested. A number from each set were broken out of the wafers and attached over one mm holes in Aluminum plates with epoxy cement. The windows were successively placed under roughing vacuum using a lubricated "O" ring for a vacuum seal. Breaking pressure was recorded for windows that did not survive. Radius of curvature of films that did survive was obtained by measuring the optical focal length in reflection. Stress and strain were deduced and the results are tabulated. Young's modulus obtained from the data assuming Poisson's ratio to be 0.3 is 346 GPa. That value is compared with values from the literature. 4 refs., 6 figs., 6 tabs.

22401 (UCRL-102294) **A test of the theory of resonant scattering between analog nuclei.** Boyd, R.N. (Ohio State Univ., Columbus, OH (USA). Dept. of Astronomy); Islam, M.S.; Kolnicki, G.; Farrell, M.; Wang, T.F.; Sale, K.E.; Mathews, G.J. Lawrence Livermore National Lab., CA (USA). 1 Nov 1989. 11p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract W-7405-ENG-48. (CONF-891044-8: 1. international conference on radioactive nuclear beams, Berkeley, CA (USA), 16-18 Oct 1989). Order Number DE90008350. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It has been suggested that strong resonances might be found in scattering between analog nuclei at energies near the Coulomb barrier. We have begun a study of such scattering for ^{7}Be on ^{7}Li using a ^{7}Be beam produced with the OSU-LLNL radioactive ion beam facility. The resulting excitation function can be used to limit a combination of the strength and the width of any possible resonances. 3 refs., 5 figs.

22402 (UCRL-102620) **Core cooling studies at LLNL [Lawrence Livermore National Laboratory] and Sandia.** Stone, R. (Lawrence Livermore National Lab., CA (USA)); VanSant, J.; Bahowick, S.; Reed, K.; Kempka, S. Lawrence Livermore National Lab., CA (USA). 9 Feb 1990. 12p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900280-2: International workshop on magnetic pulse compression, Lake Tahoe, NV (USA), 12-14 Feb 1990). Order Number DE90008303. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are conducting numerical studies and experimental tests at Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratory (SNL) to determine a method of cooling pulse compression cores that use saturating magnetic material. We anticipate that for high average power throughput compressors, cores will have cooling channels wound at intervals to maintain the maximum temperature below 125°C. We have calculated, for a range of volumetric heating rates, the expected distance between channels using bulk core properties and laminar flow for the cooling fluid. We have completed Freon-113 flow tests on possible cooling-channel materials. We have found that, in tests using ohmically heated cores without cooling channels, we can achieve good agreement between calculated and measured performance by use of the bulk ore properties and assumed film coefficients. A two-dimensional code has been developed to determine core performance using both edge and channel cooling. We are planning additional ohmic heating tests of wound cores to further investigate the performance of the cores, both with and without cooling channels. We will then compare the measured values of temperature, flow rate, and pressure drop with code results. 3 refs., 16 figs., 1 tab.

22403 **Future trends in pulsed power technology at the Center for Electromechanics at the University of Texas at Austin.** Gully, J.H. (Texas Univ., Austin, TX (USA). Center for Electromechanics); Weldon, W.F. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656-: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

In the past decade, the feasibility of using rotating electrical machines as pulsed power supplies has been demonstrated. Tokomaks, laser-flash lamps, and electromagnetic (EM) accelerators are examples of devices successfully powered by pulsed generators. Although they are not well suited for driving all loads, i.e., very high voltages (MVs) or microsecond pulse widths, for applications that require a large amount of energy (multi-MJs) and/or field portability, pulsed generators are an attractive alternative. Future trends at the Center for Electromechanics at The University of Texas at Austin (CEM-UT) are reported. They include improving energy density, power density, and shaping current and voltage waveforms as required for specific applications.

22404 **Switching devices used in the lethality test system.** Parsons, W.M. (Los Alamos National Lab., NM (USA)); Ford, R.D.; Wildi, P.; Chowdhuri, P. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656-: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The lethality test system (LTS) is an experiment which will utilize a light gas gun-railgun combination to accelerate projectiles for impact studies. The power supply for the railgun consists of an 80 MJ (kinetic generator-flywheel array used to charge the primary windings of three cryogenic pulse transformers. The secondary windings of these transformers will supply up to 50 MJ of electrical energy to the railgun. A number of special switching devices will be required to cause energy transfer and compression. This paper describes the design and testing of these switching devices.

22405 **Status of plasma opening switch development for the Particle Beam Fusion Accelerator II (PBFA II).** Rochau, G.E. (Sandia National Labs., Albuquerque, NM (USA)); McDaniel, D.H.; Moore, W.B.S.; Mowrer, G.R.; Renk, T.J.; Stinnett, R.W.; Woodall, H.N. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656-: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors have conducted plasma opening switch (POS) experiments on the PBFA II ion beam accelerator 12 MV, 100 TW, 50 ns. The POS system uses a newly developed flashboard source to provide the plasma required to conduct large currents (6 MA) over large areas (150 - 2500 cm^2). An initial series of experiments has

been completed characterizing the behavior of the POS with short circuit, electron beam diode, and applied-B ion diode loads. The tests have demonstrated the need for a more rugged plasma source with uniform plasma density and for better power flow symmetry. The summary of the test series is presented and discussed.

22406 Ultimate velocities for induction launchers. Cowan, M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The ultimate velocity achievable with railguns will probably be determined by how well one can manage to minimize barrel effects associated with the need for sliding electrical contact between the rails and the armature. However, in principle, electromagnetic launchers can use levitated projectiles which are propelled by induced currents. Then barrel effects can be eliminated altogether, and the ultimate velocity is determined by ohmic heating of the projectile. In this paper, the velocity capabilities for these kinds of launchers–called induction launchers–are discussed. Requirements and pulsed power implications for achieving velocities in the 10-100 km/s range are developed.

22407 Pulsed power safety and technical training at Sandia National Laboratories. Goldstein, S.A. (Sandia National Labs., Albuquerque, NM (USA)); Zawadzkas, G.A.; Donovan, G.L.; Mikkelson, K.A.; Sharpe, A.W.; Johnston, R.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The expansion of pulsed power applications research at Sandia National Labs requires increasing technician-level support from individuals trained in high voltage, short pulse technology. Large superpower generators need a broad-based training curriculum in all aspects of accelerator operation to satisfy recent Department of Energy (DOE) desires for formal certification of accelerator operators. This paper discusses the status of Sandia's safety and technical training program in pulsed power technology directed mainly towards high school graduate and technical school level students. Present safety training methodology requires that hazards for experimental facilities are identified first, a specific curriculum is then tailored to individuals' background experiences and hazards involved with their current assignments. In the technical training program, certification requirements are being established and a coursework program has been initiated in which subjects are organized into two sections. The first covers electrical principles and physical properties of pulsed power components. The second presents various support-type subsystems for accelerators.

22408 TEM analysis and computer simulations of DEMON and PBFA-II open transmission-line systems. Johnson, W.A. (Pulsed Power Sciences Directorate, Sandia National Labs., Albuquerque, NM (USA)); Neau, E.L.; Schneider, L.X. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The paper presents transverse electromagnetic (TEM) multimode analysis and 3-dimensional, time-dependent computer simulations, as well as experiments, carried out to quantify the energy-transport efficiencies of the open transmission-line systems of the Particle Beam Fusion Accelerator II (PBFA II) and the DEMON accelerator. The insights gained are discussed. They are guiding design efforts to improve the energy-transport efficiency of PBFA II.

22409 PBFA II: The pulsed power characterization phase. . Martin, T.H. (Sandia National Labs., Albuquerque, NM (USA)); Turman, B.N.; Goldstein, S.A.; Wilson, J.M.; Cook, D.L.; McDaniel, D.H.; Burgess, E.L.; Rochau, G.E.; Neau, E.L.; Humphreys, D.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The Particle Beam Fusion Accelerator II (PBFA II) is now the largest pulsed power device in operation. The paper summarizes its first year and a half of operation for the Department of Energy (DOE) Inertial Confinement Fusion (ICF) program. Thirty-six separate modules provide 72 output pulses that combine to form a 100 TW output pulse at the accelerator center. PBFA II was successfully test fired for the first time in 1985.

22410 The Hermes-III program. Ramirez, J.J. (Sandia National Labs., Albuquerque, NM (USA)); Prestwich, K.R.; Burgess, E.L.; Furaus, J.P.; Hamil, R.A.; Johnson, D.L.; Sanford, T.W.L.; Seamons, L.O. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Hermes III is a gamma ray simulator. It will deliver a 20-ns FWHM, 20-ns 10% to 90% rise time, radiation pulse with a peak dose rate of 5×10^{12} rad(Si)/sec over a cylindrical volume with a 500-cm^2 front surface area and 15 cm long. The radiation pulse will be uniform within a factor of two across the front surface and within a factor of four anywhere within the volume. The minimum dose rate will be 2.5×10^{12} rad(Si)/sec within this volume. The overall configuration of the Hermes-III accelerator is presented together with a discussion of the requirements for the individual components. A summary of the subsystems' performance obtained to date is also presented.

22411 Troll: A 4-MV peak voltage pulser. . Bushnell, A.H. (Maxwell Labs., Inc., San Diego, CA (USA)); Chen, Y.G.; Shannon, J.; Clark, R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report on the development of a 4 MV peak voltage pulser for the Troll accelerator has been designed. The pulser is required to produce a flat-top pulse, with a variable width, to drive a cold-cathode diode. The system operates over a range of 2 to 4 MV. A 46-stage Marx generator is used to directly drive the diode. The diode impedance is relatively high and causes overshoot of the output voltage due to the stray capacitance of the Marx generator. To reduce the overshoot, a unique snubber network was used to damp out the oscillations. The pulse width is controlled over a range of 250 ns to 2 μs by a diverter switch. The switch is a hybrid two-stage spark gap, with the first gap in trigatron configuration and the second gap self-closed by overvoltage from the first gap.

22412 The PT1 linear induction accelerator. Stinnett, R.W. (Sandia National Labs., Albuquerque, NM (USA)); Buttram, M.T.; Ginn, J.W.; Hamil, R.A.; Harjes, H.C.; Lancaster, K.T.; Loubriel, G.M.; Poukey, J.W. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors discuss how they developed a concept for a compact, modular, linear-induction accelerator that demonstrates the technology required to produce long bursts of short (20 ns FWHM), closely spaced, relatively high current (1 kA), electron-beam pulses. A photoconductive semiconductor switch (PCSS) system is used to produce trains of short pulses directly from the output of a long pulse transformer. The average gradient of this accelerator will be 1.6 MV/m.

22413 A multi-megavolt, two-microsecond electron beam diode. Clark, R.S. (Sandia National Labs., Albuquerque, NM (USA)); Buttram, M.T.; Poukey, J.W.; Lockner, T.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

An electron beam diode hs been developed that operates in the multi-megavolt, microsecond regime. It is a foilless diode with a field emission (cold) cathode designed to produce a 1-kA to 10-kA beam at up to 4 MV. It employes a unique cathode geometry to prevent excessive beam divergence. The diode has been operated in the 2-MV to 3.5-MV range. Currents at the present operating parameters are 1.8 kA to 3.0 kA. A description of the diode, the diode design criteria, and experimental results to date are presented.

22414 Indented-anode diode for Hermes III. Sanford, T.W.L. (Sandia National Labs., Albuquerque, NM (USA)); Poukey, J.W.; Halbleib, J.A.; Pate, R.C.; Crowder, G.W.; Borkey, T.; Current, F.; Heath, C.E.; Mock, R.; Spence, P.W. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Design of three diode configurations that meet the radiation goals of HERMES III and calculation of associated radiation outputs are discussed. These goals are: to produce a 20-ns FWHM radiation pulse having a peak dose rate of 5×10^{12} rad(Si)/s with a variation of less than a factor of two over a 500 cm^2 irradiation area, to keep the variation less than a factor of four over the irradiation volume defined by extending the area downstream by 15 cm, and to maintain a minimum dose rate over this volume in excess of 2.5×10^{12} rad(Si)/s.

22415 The PTO linear induction accelerator. Lancaster, K.T. (Sandia National Labs., Albuquerque, NM (USA)); Stinnett, R.W.; Buttram, M.T.; Clark, R.S.; Ginn, J.W.; Poukey, J.W. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The PTO accelerator is a test-bed for the study of issues involved in the development of compact, repetitive, high-duty cycle, linear induction accelerators (LIA). The need for multi-microsecond pulse lengths is incompatible with compact ferrite size. Therefore, a long burst of short pulses with a 100% voltage reversal and a 50% duty cycle was chosen as the operating mode of PTO. The 100% voltage pulse reversals between accelerating pulses reset the magnetic cores, allowing a compact ferrite size. PTO will consist of an 800-kV injector to generate an electron beam (–1 kA) and two 200-kV induction cavities to accelerate the beam. Two different operational modes will be implemented. The first (drive mode 1) is a short burst (three pulses) of high frequency (20-MHz) bipolar square waves to study diode beam dynamics and to characterize accelerating cavity behavior. Drive mode 2 will be a multi-microsecond ringing waveform (with much greater interpulse spacing) that will alternately saturate the cores in each polarity. This driving mechanism will facilitate the study of plasma closure rates in the diode and accelerating gaps. The pulsed power and cavity designs are presented.

22416 Testing of the inductive cores for Hermes III. Huddle, C.W. (Sandia National Labs., Albuquerque, NM (USA)); Johnson, D.L.; Denison, G.J.; Franklin, T.L. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

This paper describes the testing of magnetic cores for the twenty inductively isolated cavities in Hermes III. In this accelerator, the 1.1-MV, 220-kA outputs from four pulse-forming modules will be added in parallel in each of the twenty cavities. The 1-MV, 800-kA summed pulses are fed through the cavities and added by a magnetically insulated transmission line (MITL) to produce a 20-MV, 800-kA output pulse. Cores from two manufacturers were procured for testing. Each set of cores was specified to have a 0.064 volt . second product to isolate a 1-MV, 40-ns FWHM pulse. The critical properties of these pre-annealed, Metglas-alloy 2605CO cores are their B-H loop characteristics and high-voltage insulation capabilities. The B-H loops measured at 60 Hz, 33 kHz, and with a 60-ns pulse indicate a 3.4-T swing. High-voltage life testing was done with a 250-kV, 60-ns pulser. The cores from both manufacturers were pulsed at the Hermes-III design voltage level for greater than 5000 pulses without failures.

22417 A simple self-breaking 2 MV gas switch. DiCapua, M.S. (Lawrence Livermore National Lab., CA (USA)); Freytag, E.K.; Dixon, W.R.; Hawley, R.A. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract W-7405-ENG-48. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors describe a simple self-breaking 2 MV gas master switch for a 2 MV general purpose relativistic electron beam (REB) accelerator. The switch cavity has been hollowed out in a 17.8 cm-thick acrylic slab. The switch gap is 3.55 cm. At 2 MV the maximum field at the cathode is 740 kV cm^{-1} and the maximum envelope field is 172 kV cm^{-1}. The maximum measured switching voltage is 1.90 +-0.1 MV (10 bar abs). The minimum switching voltage is 1.1 mV (4.3 bar abs). The operating characteristics break away from the 89 kV/(cm atm) DC breakdown strength of SF_6 at 5.5 bar abs. The authors discuss how the electrical and mechanical design as well as quality control during assembly and operation have resulted in reliable and reproducible operation.

22418 Alignment of the Hermes-III magnetically insulated transmission line. Burgess, E.L. (Sandia National Labs., Albuquerque, NM (USA)); Crowder, G.W.; Dowdican, M.C.; Patterson, J.C.; Franklin, T.L.; Robischon, S.J.; Tolk, K.M.; Ramirez, J.J.; Johnson, D.L.; Pate, R.C. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Hermes-III is a 20-MV machine which contains an 18.7-m-long magnetically insulated transmission line (MITL). The cylindrical MITL cathode is cantilevered from one end and must be accurately aligned within the anode. This paper describes the mechanical design for accomplishing this alignment.

22419 PBFA-II energy storage system performance and operation. Wilson, J.M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

PBFA-II is a thirty-six module ion beam accelerator for inertial confinement fusion feasibility studies. Each module of the machine is designed to deliver 2.8 terawatts to a central experimental chamber. The total power delivered to the ion diode (100 terawatts) is expected to permit ignition scaling studies beginning in the late 1980's. The PBFA-II energy storage system is located in an annular oil tank at the outer periphery of the accelerator. Its main component is a set of thirty-six 6.0 MV, 400 kJ Marx generators. In order to properly drive the machine's downline pulse-forming section and the accelerator load, the Marx generator set must erect with a first-to-last spread of less than 40 nsec. The energy storage section is triggered by a chain of pulse amplifiers, beginning with a low voltage trigger pulse from the main control system and culminating in thirty-six 540 kV, 80 nsec risetime pulses used to trigger the Marx generators. Each generator then erects to provide a 110 kA, 5.3 MV, 1.3 μsec pulse to charge the pulse-forming section.

The energy storage system is now operational and meeting performance specifications. The performance characteristics of the system are reported for the present operating range. Routine operation and maintenance procedures are discussed.

4304 Storage Rings

Refer also to citation(s) 22374, 22385, 22388

22420 (LBL–27812) **Stability against temperature variations at the ALS.** Warwick, T.; Swain, T.; Jackson, A. Lawrence Berkeley Lab., CA (USA). Aug 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890802–24: 7. synchrotron radiation instrumentation (SRI) national conference, Berkeley, CA (USA), 6-10 Aug 1989). Order Number DE90007765. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effects of temperature fluctuations on the Advanced Light Source (ALS) have been studied. By modeling the storage ring support structure, we find that fluctuations of +/−2 to 3 °C in the tunnel will cause photon beam motion of the order of the beam size. Temperature stabilization at this level will allow the residual motion of the photon beams to be reduced by a second level of active feedback, operating on signals from photon beam position of monitors. Air temperature in the experimental area and the temperature of cooling water serving the beamlines should be constant to +/−1 °C. This will provide a suitable environment for experiments. The ALS is a third generation synchrotron radiation source, based on an electron storage ring, designed to produce extremely bright photon beams in the VUV and soft X ray region of the electromagnetic spectrum. The high brightness arises as a direct consequence of the small emittance of the circulating electron beam in the ALS. In order to exploit the high brightness it is necessary to maintain the stability of the electron beam, and the stability of the optical elements that transport the photon beam to the sample, to very high precision. 13 refs., 7 figs.

44 INSTRUMENTATION

4401 Radiation Instrumentation

Refer also to citation(s) 21571, 21693, 21703, 21720, 21738, 22213, 22381, 22763, 22765, 22863, 22879, 22883, 22896, 22915, 22927, 22948, 22949, 22964

22421 (AD-A–214564/7/XAB) **PROTEL: Design, fabrication, calibration, testing, and satellite integration of a proton telescope. Environmental research paper.** Lynch, K.A.; Boughan, E.A.; Fischi, D.K.; Hardy, D.A.; Riehl, K.B. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 16 Feb 1989. 86p. (AFGL-TR–89-0045). Available from NTIS, PC A05/MF A01.

A high energy proton telescope, PROTEL, was designed, fabricated, calibrated, tested, and integrated as part of the SPACERAD experiment for the Combined Release and Radiation Effects Satellite (CRRES) payload. As designed, PROTEL measures the differential energy spectrum of protons in 24 channels logarithmically spaced from 1 to 100 MeV, and the approximate flux of heavy ions. It consists of a Data Processing Unit (DPU), and two sensor head assemblies (High and Low Energy Head). The active elements of the sensor heads are stacked arrays of silicon-lithium drifted and surface-barrier solid-state detectors. This report describes the basic design, the command system, and the telemetry format of PROTEL, as well as the test and calibration results for the detector-head assemblies, and electronic logic system obtained with several accelerators. Also described are results of computer modeling of the responses of the instrument, particularly the estimation of pulse pileup and efficiency.

22422 (ANL-HEP-CP–90-2) **First level trigger processor for the ZEUS calorimeter.** Dawson, J.W. (Argonne National Lab., IL (USA)); Talaga, R.L.; Burr, G.W.; Laird, R.J.; Smith, W.; Lackey, J. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-900143–29: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990). Order Number DE90007793. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the design of the first level trigger processor for the ZEUS calorimeter. This processor accepts data from the 13,000 photomultipliers of the calorimeter which is topologically divided into 16 regions, and after regional preprocessing, performs logical and numerical operations which cross regional boundaries. Because the crossing period at the HERA collider is 96 ns, it is necessary that first-level trigger decisions be made in pipelined hardware. One microsecond is allowed for the processor to perform the required logical and numerical operations, during which time the data from ten crossings would be resident in the processor while being clocked through the pipelined hardware. The circuitry is implemented in 100K ECL, Advanced CMOS discrete devices, and programmable gate arrays, and operates in a VME environment. All tables and registers are written/read from VME, and all diagnostic codes are executed from VME. Preprocessed data flows into the processor at a rate of 5.2GB/s, and processed data flows from the processor to the Global First-Level Trigger at a rate of 700MB/s. The system allows for subsets of the logic to be configured by software and for various important variables to be histogrammed as they flow through the processor. 2 refs., 3 figs.

22423 (BONN-IR–89-38) **The scintillation counter system at the SAPHIR detector.** Bour, D. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Oct 1989. 95p. (In German). Order Number DE90759512. Available from NTIS (US Sales Only), PC A05/MF A01.

The scintillation-counters system of the SAPHIR-detector at the stretcher accelerator ELSA in Bonn consists of 64 counters. It supplies a fast hadronic trigger and is utilizised for the particle identification by time of flight measurements. Prototypes of the counters (340x21.25 x 6.0 cm^3) had been tested. The contribution to the resolution of the time of flight measurement was measured to σ=125 ps, the effective light velocity to 17.5 ns/cm and the attenuation length of 7.8 m. A pion kaon separation is possible up to a momentum of 1 GeV/c with time of flight measurement. With the first photon-beam at SAPHIR the counters were tested, first triggers were obtained and evaluated. (orig.).

22424 (BONN-IR–89-47) **Position calibration of the drift chamber system of the Bonn SAPHIR experiments by means of real particles.** Schenk, U. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1989. 39p. (In German). Order Number DE90759511. Available from NTIS (US Sales Only), PC A03/MF A01.

For tagged photon experiments at the new accelerator facility ELSA a large solid angle detector 'SAPHIR' was built. A central part of this detector is the drift chamber system. Besides the exact knowledge of the relation between the track position and the drift time the relative position of the different chambers is of fundamental importance for the accuracy of the momenta of the detected particles. In this paper a method of measuring the relative positions of these drift chambers by use of the tracks of real particles is described. (orig.).

22425 (BONN-IR–89-48) **Construction and test of a gas system for the supply of a jet chamber.** Wendt, M. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1989. 50p. (In German). Order Number DE90759514. Available from NTIS (US Sales Only), PC A03/MF A01.

An existing test jetchamber has been made operational by the installation of an appropriate gas system. As the chamber is to study problems of the OPAL jetchamber, its gas system has to meet requirements similar to that of OPAL: Set-up of very well defined gas mixtures at given pressure, removal of residual O_2 molecules and admixture of a small amount of H_2O. After successful testing of the single components, measurement of the drift velocity v_d was used as a functional test of the overall system. Excellent agreement has been achieved with existing OPAL drift velocity-data. (orig.).

22426 (BONN-IR–89-50) **The influence of saturation effects in the gas amplification on the pulse height distribution of**

minimum ionizing particles. Kueper, G. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1989. 57p. (In German). Order Number DE90759515. Available from NTIS (US Sales Only), PC A04/MF A01.

The results of several measurements show the influence of saturation effects on the pulse height distribution, caused by high charge densities in proportional counting tubes. Measurements with monoenergetic X-rays were made to examine the dependence of total ionisation and pulse height. Further experiments with minimum ionizing particles, directed parallel or vertical to the signal wire, and with different track lengths give an explanation for a better energy resolution of a gas sandwich detector, using high gains in gas amplification, where the particles come mostly parallel to the signal wire. Such a gas sandwich calorimeter was developed in Bonn with an energy resolution of $\sigma/E=13.3\%/\sqrt{E(GeV)}$. (orig.).

22427 (BONN-IR-89-51) **The muon trigger of the SAPHIR shower detector.** Rufeger-Hurek, H. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1989. 72p. (In German). Order Number DE90759513. Available from NTIS (US Sales Only), PC A04/MF A01.

The muon trigger system of the SAPHIR shower counter consists of 4 scintillation counters. The total trigger rate of cosmic muons is about 55 Hz which is reduced to about 45 Hz by the selecting algorithms. This rate of clean muon events allows a simultaneous monitoring of the whole electronics system and the calibration of the gas sandwich detector by measuring the gas gain. The dependences of the signals on the geometry have been simulated with the help of a Monte Carlo program. The comparison of simulated and measured pulse heights shows that faults in the electronics as well as defects in the detector hardware, e.g., the HV system, or temperature effects, can be recognized at the level of a few percent. In addition the muon signals are used to determine the calibration factor for each cathode channel individually. (orig.).

22428 (CRN-CPR-84-5) **Characterisation of the light pulses of a cavity dumped dye laser pumped by a cw mode-locked and q-switched Nd:YAG laser.** Geist, P. (Strasbourg-1 Univ., 67 (FR). Centre de Recherches Nucleaires); Heisel, F.; Martz, A.; Miehe, J.A.; Miller, R.J.D. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1984. 6p. (In French). (CONF-840887-: 16. international congress on high speed photography and photonics, Strasbourg (France), 27-31 Aug 1984). Order Number DE90756441. Available from NTIS (US Sales Only), PC A02/MF A01.

The frequency doubled pulses (of 532 nm) obtained, with the help of a KTP crystal, from those delivered by either a continuous wave mode-locked (100 MHz) or mode-locked Q-switched (0-1 KHz) Nd: YAG laser, are analyzed by means of a streak camera, operating in synchroscan or triggered mode. In the step-by-step measurements the pulse stability, concerning form and amplitude, is shown. In addition, measurements effectuated with synchronously pumped and cavity dumped dye laser (Rhodamine 6G), controlled by a Pockels cell, allows the obtention of stable and reproducible single pulses of 30 ps duration, 10 μJ energy and 500Hz frequency.

22429 (EGG-10617-2051) **Mercuric iodide room temperature gamma-ray detectors.** Patt, B.E. (EG and G Energy Measurements, Inc., Goleta, CA (USA)); Markakis, J.M.; Gerrish, V.M.; Haymes, R.C.; Trombka, J.I. EG and G Energy Measurements, Inc., Goleta, CA (USA). [1989]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-891276-5: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90008751. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

High resolution mercuric iodide room temperature gamma-ray detectors have excellent potential as an essential component of space instruments to be used for high energy astrophysics. Mercuric iodide detectors are being developed both as photodetectors used in combination with scintillation crystals to detect gamma-rays, and as direct gamma-ray detectors. These detectors are highly radiation damage resistant. The list of applications includes gamma-ray burst detection, gamma-ray line astronomy, solar flare studies, and elemental analysis. 3 refs.

22430 (EUR-CEA-FC-1361) **Spatially resolved soft x-ray (1 - 33 nm) spectroscopy of tokamak plasmas.** Breton, C.; Michelis, C. de; Mattioli, M.; Monier, P.; Ramette, J.; Saoutic, B. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. Apr 1989. 13p. Available from NTIS (US Sales Only), PC A03/MF A01.

We describe the space-resolved soft x-ray (1 - 33 nm) instrumentation developed for the Tore Supra Tokamak. By using a programmable hydraulic jack to move the spectrometer, several spatial profiles (up to ten) of many impurity lines are obtained during a single plasma discharge, with a time resolution which can be as short as 600 ms.

22431 (GSI-90-01(prepr.)) **Calorimetric cryodetectors for heavy ions.** Egelhof, P. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Henning, W.; Kienlin, A. v.; Meier, J.; Truebenbacher, V.; Azgui, F.; Shepard, K. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jan 1990. 9p. Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

Status and first test results are reported for a project to develop calorimetric cryodetectors for heavy ions. The special conditions for the detection of energetic heavy ions are discussed. Presently the investigations are focussed on semiconductor bolometers and aluminium-strip superconducting phase-transition thermometers that are cooled with liquid ^{4}He and operate in the temperature range 1.3-4.2 K. For a germanium bolometer the temperature dependence of the resistance, voltage-current curves, the time response to heating by voltage pulses and the response to ionizing α-radiation are reported. First tests on phase transition thermometers using thin aluminum strips yield a transition width of $\Delta T=8.6$ mK at $T_c=1.467$ K. (orig.).

22432 (GSI-90-02(prepr.)) **Response of BaF_2 detectors to photons of 3-50 MeV energy.** Matulewicz, T.; Grosse, E.; Emling, H.; Freifelder, R.; Grein, H.; Henning, W.; Herrmann, N.; Holzmann, R.; Kulessa, R.; Simon, R.S. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jan 1990. 33p. Contract W-31-109-ENG-38. Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

BaF_2 detectors of 20 cm length (10 radiation lengths) and hexagonal cross section (diameter 5.2 cm) were tested using monochromatic photons from the tagged-photon facility at the electron accelerator MAMI A at Mainz. The experimental spectra of the deposited energy for a single detector and for an array of seven modules compare very well with the predictions of Monte Carlo shower simulations using the code GEANT3. At high photon energies a significant improvement (more than a factor 2) of the energy resolution is observed for the summed energy spectra as compared to the resolution of one single module. (orig.).

22433 (IAEA-R-5012-F) **Design, development and construction of an X-ray total reflection module: Final report for the period 15 March 1986 - 11 March 1989.** Wobrauschek, P. Atominstitut der Oesterreichischen Universitaeten, Vienna (Austria); International Atomic Energy Agency, Vienna (Austria). Nov 1989. 44p. Order Number DE90617896. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mechanical attachment was developed to be mounted on the shielding housing on an X-ray tube. It permits the X-ray fluorescence measurements in the total reflection conditions. The detailed drawings are available; the attachment can be constructed in any good mechanical workshop. Several tests were performed to determine the sensitivity limits of the system. As a typical example, in a 1,000 seconds measurement, with an X-ray tube with molybdenum anode, at 50kV and 16mA, the standard detection limit for selenium was 50 pg. A short description of sample preparation procedure is presented. 4 refs., figs.

22434 (IFVE-OEF–88-179) **GAMS-2000 spectrometer data acquisition system.** Binon, F. (Institut Interuniversitaire des Sciences Nucleaires, Brussels (Belgium)); Guaner, M.; Donskov, S.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 30p. (In Russian). Order Number DE90620305. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

GAMS-2000 hodoscopic spectrometer data acquisition system, including 1536 channels of the pulse-height analysing electronics and fast processor for preliminary data handling is described. The main testing and control procedure are considered. 31 refs.; 12 figs.; 3 tabs.

22435 (IFVE-OEF–88-215) **Suppression of one-electron noise in scintillation counters.** Guz, Yu.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij); Lapin, V.V.; Lapshin, V.G.; Peresypkin, A.I.; Rykalin, V.I.; Skripkina, V.T. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 12p. (In Russian). Order Number DE90620306. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Two methods are proposed and have been studied to reduce one-electron noise in a scintillation counter. The methods are based on the shape difference of the signal and noise pulses. For a low signal (few electrons) the use of any of the two methods allows one to reduce the noise by a factor of $10\text{-}10^2$. At the same time the resolution and efficiency are satisfactory. 15 refs.; 5 figs.

22436 (IFVE-ONF–88-211) **Plastic tube hadron calorimeter: study of operation properties and particle separation.** Akopdzhanov, G.A.; Belousov, V.I.; Blik, A.M.; Romanovski, V.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 11p. Order Number DE90620307. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The DELPHI hadron calorimeter prototype plastic tubes were tested to show a long-term stability of the prototype operating with the gas mixture carbon dioxide isobutane. The operating properties of the prototype are investigated and presented as well as the results on particles separation. 5 refs.; 11 figs.; 9 tabs.

22437 (IFVE-ONF–88-216) **Electron and hadron discrimination in cell electromagnetic calorimeter of lead-scintillator sandwich type.** Ivanyushkin, Yu.M.; Kistenev, Eh.P.; Kubik, V.M.; Pishchal'nikov, Yu.M.; Kholodenko, A.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 14p. (In Russian). Order Number DE90620308. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Additional light-guide-shifter which collects light only from scintillation plates arranged in maximum of electromagnetic shower is suggested to use to improve efficiency of electron and hadron separation in the module of hodoscopic detector GEPARD. Using a model of nine modified modules, data on efficiency of electromagnetic and hadron showers separation both in the value of dispersion of transverse distribution of energy in shower and in value of the ratio of energy separation in the region of shower maximum to the total energy separation are obtained. 10 refs.; 7 figs.

22438 (IFVE-ONF–88-217) **Stand for testing photomultipliers FEU 84-3.** Akopyan, M.V. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij); Medved', S.A.; Pishchal'nikov, Yu.M.; Skripachev, O.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 14p. (In Russian). Order Number DE90620309. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In IHEP for testing photomultipliers of the GEPARD-200 and BARS detectors the computerized stand is constructed which allows to test 10^4 FEU 84-3 photomultipliers of several parameters: anode sensitivity, long and short term gain instabilities.

22439 (INIS-mf–11552) **A new gamma camera for positron emission tomography.** Schotanus, P. Technische Univ. Delft (Netherlands). 20 Sep 1988. 200p. Order Number DE90706044. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

This thesis describes the detection of annihiliation radiation employing a new principle: radiation is absorbed in a barium fluoride (BaF 2) crystal and the resulting scintillation light is detected in a multiwire proportional chamber filled with a photosensitive vapour. The application of such a detector for PET is new; the use of a high density fast scintillator in combination with a low pressure wire chamber offers a good detection efficiency and permits high count rates because of the small dead time. In this work, the physical background of the above detection mechanism is explored and the performance parameters of a gamma camera using this new principle, are determined. Furthermore, a comprehensive research on the scintillation mechanism and physical characteristics of the increasingly popular BaF 2 scintillator is presented. Also, a new class of ultraviolet (UV) scintillation materials, consisting of rare earth doped fluorides, is introduced. 211 refs., 30 figs., 17 tabs.

22440 (ISN–89-31) **Use of the photovoltaic cells as fission fragment sensors and study of a preamplifier adapted to the cells.** Jin Yimeng. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. Apr 1989. 131p. (In French). Order Number DE90756354. Available from NTIS (US Sales Only), PC A07/MF A01.

In the detection of heavy ions and fission fragments, the photovoltaic cells can take the place of traditional silicon surface barrier detectors, if we need a great number of detectors as in the case of 4π multidetector, and do not expect excellent energy and time resolutions at the same time. Made for the purpose of converting the solar energy to the electrical energy, the photovoltaic cells have the similar structure as silicon surface barrier detectors, except for their much thinner pn junctions and, as a result much larger junction capacities, which is a major disadvantage for photovoltaic cells as fission fragment detectors. In order to get an acceptable energy resolution and a time resolution as good as possible, it is necessary to design a preamplifier specially adapted to cells, which plays a very important role in the utilization of photovoltaic cells as detectors. In the present work we analyze the electrical signal from a cell when hit by a fission fragment, and propose a new type cell oriented preamplifier of voltage, with which we can use a cell up to 10 cm^2, and obtain a time resolution better than 16 ns.

22441 (IYaF–88-30) **Information plate A32 of the KLUKVA data acquisition system.** Aul'chenko, V.M.; Leont'ev, L.A.; Usov, Yu.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1988. 8p. (In Russian). Order Number DE90620311. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Design of new detectors KMD-2, SND and KEDR is required the development of a specialized system for data acquisition. Information plates placed in special crates of the system bear main load in detector signal processing. Plate A32 being 32-channeled analog-to-digital converter is described. Specifications of plate A32 are given: input numbers-32, dynamic range-4096 channels, input signal $\leq$ 2 V. 1 refs.; 2 figs.

22442 (KURRI-TR–318, pp. 1-5) **Performance of anti-compton spectrometers.** Inoue, H. (Hiroshima Univ. (Japan). Faculty of Science (Japan)). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. COMPTON SPECTROMETERS/specifications; SPECIFICATIONS; ENERGY RESOLUTION; INTERNATIONAL COOPERATION; PERFORMANCE TESTING; GE SEMICONDUCTOR DETECTORS; CESIUM 137; AMERICIUM 241; USES; COBALT 60; BGO DETECTORS; EUROPIUM 152; BARIUM FLUORIDES

22443 (KURRI-TR–318, pp. 6-10) **High resolution crystal ball.** Iwata, Y. (Hiroshima Univ. (Japan). Faculty of Science). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st*

specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor. Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

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22444 (KURRI-TR–318, pp. 18-21) **A four-detector system for γ-γ angular correlation.** Yamada, S. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.); Okano, K. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. ANGULAR CORRELATION/measuring methods; GAMMA SPECTROMETERS; LI-DRIFTED GE DETECTORS; GE SEMICONDUCTOR DETECTORS; COINCIDENCE CIRCUITS; DISPLAY DEVICES; DATA TRANSMISSION; COBALT 60; GAMMA RADIATION

22445 (KURRI-TR–318, pp. 91-94) **Measurements of the response function of an LEPS to positrons.** Osa, A. (Nagoya Univ. (Japan). Faculty of Engineering); Miyachi, M.; Shibata, M. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. POSITRON BEAMS/response functions; GALLIUM 68; BETA SPECTROMETERS; MEASURING METHODS; ENERGY DEPENDENCE; MONTE CARLO METHOD; BETA SPECTRA; COPPER 62; CHLORINE 34; BETA SPECTROSCOPY

22446 (LBL–27394) **LAr calorimeter for SCC with a common vacuum bulkhead—a concept to improve hermeticity.** Pope, W.L. (Lawrence Berkeley Lab., CA (USA)); Watt, R.D. Lawrence Berkeley Lab., CA (USA). Nov 1989. 47p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008055. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new concept for a Barrel/Endcap LAr Calorimeter (LAC) is described in which the Barrel and Endcaps are in separate vacuum enclosures but share a common vacuum bulkhead (CVB). We explore 2 possible bulkhead construction types; welded plate sandwich panels, and brazed sandwich panels in which the core is an isotropic cellular solid–foamed aluminum. Gas lines and electric cables from he innermost Drift Chamber pass through radial holes in the core of the sandwich bulkhead. The CVB concept offers the potential to obtain a more hermetic calorimeter with significantly reduced dead material and/or space in the interface region common to conventional design LAr detectors for the SSC with Endcap features. To utilize a common additional steps to remove the Drift Chamber, a large increase in Endcap standby heat leak, and perhaps, new cryogenic safety issues. We find that significant amount of dead mass can be removed from critical regions of the vacuum shells when compared to a promising SSC LAC reference design. It is also shown that the increased standby heat leak of this concept can be easily removed by existing cooling capacity in another large LAr calorimeter. It is further shown that shut-downs need not be appreciably longer. Finally, it is argued that cryogen spill hazards can be avoided if the Endcap's LAr is removed during Drift chamber maintenance shutdowns, and that cryogenic safety is not compromised.

22447 (LBL–28481) **Amorphous silicon detectors in positron emission tomography.** Conti, M. (Istituto Nazionale di Fisica Nucleare, Pisa (Italy)); Perez-Mendez, V. Lawrence Berkeley Lab., CA (USA). Dec 1989. 70p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00098. Order Number DE90008074. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The physics of the detection process is studied and the performances of different Positron Emission Tomography (PET) system are evaluated by theoretical calculation and/or Monte Carlo Simulation (using the EGS code) in this paper, whose table of contents can be summarized as follows: a brief introduction to amorphous silicon detectors and some useful equation is presented; a Tantalum/Amorphous Silicon PET project is studied and the efficiency of the systems is studied by Monte Carlo Simulation; two similar CsI/Amorphous Silicon PET projects are presented and their efficiency and spatial resolution are studied by Monte Carlo Simulation, light yield and time characteristics of the scintillation light are discussed for different scintillators; some experimental result on light yield measurements are presented; a Xenon/Amorphous Silicon PET is presented, the physical mechanism of scintillation in Xenon is explained, a theoretical estimation of total light yield in Xenon and the resulting efficiency is discussed altogether with some consideration of the time resolution of the system; the amorphous silicon integrated electronics is presented, total noise and time resolution are evaluated in each of our applications; the merit parameters $\epsilon^2\tau$'s are evaluated and compared with other PET systems and conclusions are drawn; and a complete reference list for Xenon scintillation light physics and its applications is presented altogether with the listing of the developed simulation programs.

22448 (PNL–6100-Pt.4, pp. 26-28) **Microscopic dosimetry of ions in nanometer sites: Touchers.** Wilson, W.E.; Paretzke, H.G. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Two types of events are of primary importance in the submicron dosimetry of fast protons. The foremost are those events caused by protons that pass through the site, and therefore called crossers. Second are events caused by protons that pass outside the site but that deposit energy via secondary electrons (delta-rays) that do enter the site. Such events have been called touchers. As part of the continuing study of the systematics of proton track structure, the ionization and energy deposition distributions is being computed for toucher events for 0.3 to 20 MeV protons and sites from 10 to 200 nm as a function of radial distance (eccentricity) from the proton path. Results to date, since this type of event is rare, are best described by the radial dependence of the total event frequency and by the frequency distribution for event size when a nonzero event does occur.

22449 (RAL–89-095) **HOLRED - a machine for the replay of holograms made in a large bubble chamber.** Aderholz, M. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.)); Allport, P.P.; Baton, J.-P. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 27p. Order Number DE90620312. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Fermilab 15' Bubble Chamber, exposed to a beam of neutrinos generated at the Fermilab Tevatron, has been equipped with holographic optics in order to provide a high resolution view of particle interactions over a volume of several m^3. A machine, "Holred", has been constructed to replay the holograms recorded. The principles of the machine and aspects of its construction and operation are described. Results are presented comparing holographic and conventional recordings of neutrino interactions. (author).

22450 (UCRL–100794-Rev.1) **Environmental corrections for a neutron-induced gamma-ray spectroscopy logging system in an air-filled borehole: Revision 1.** Hearst, J.R. (Lawrence Livermore National Lab., CA (USA)); Conaway, J.G.; Mathews, M.A.; Barber, J.W. Lawrence Livermore National Lab., CA (USA). Jan 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900143–31-Rev.1: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990). Order Number DE90008416. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When a nuclear explosive is tested underground, rock in the immediate vicinity of the explosion is heated to very high temperatures. If any of that rock contains carbonates, these are dissociated and the carbon may combine with oxygen to form carbon dioxide, increasing the hazard of a possible leak of radioactive gas. We are trying to adapt a commercial neutron- induced gamma-ray spectroscopy log to estimate carbonate content in emplacement boreholes at the Nevada Test Site. Such a log would test a much larger sample than the few grams currently used in sample analysis and would be continuous rather than discrete. We have performed large-scale laboratory experiments using test boxes filled with mixtures of silica sand and crushed limestone. These tests showed that the log is sensitive not only to carbonate content but also to water content of the formation as well as the gap between the logging sonde and the wall of the borehole. We modified the sonde to measure the sonde-wall gap and developed procedures for correcting the measured carbonate content for water content and gap. When we used these procedures in the laboratory, with a moving sonde and a rough surface on the test mixture. Tests in boreholes have shown good qualitative agreement with the trends in the sample data but generally indicated somewhat higher equivalent CO_2 content. The spectral data is manipulated through the use of Monte Carlo calculations. 14 refs., 17 figs.

22451 (VR–89-05, pp. 316-319) **Calibration of non-parallel ionization chambers at high energy electron radiation.** Wittkaemper, F.W. Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. (In Dutch). In *Reports from the RIVM 1988.* Order Number DE90619461. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

In order to fulfill the desired accurateness with which absorbed doses have to be measured in radiotherapy, an accurate and good reproducible calibration of the measuring equipment is demanded. A calibration method of plan-parallel ionization chambers is presented. The method is based upon a comparison of the response of this type chamber in relation to a calibrated cylindrical ionization chamber, with known conversion- and correction factors, in a high-energetic electron beam ($E > 18$ MeV). The absorbed dose for a number of electron energies has been measured in a reference point in water. By positioning the plan-parallel chamber at the same point and irradiating with the same dose the necessary factors for this chambr could be determined. With this method the conversion- and correction factors could be determined with sufficient accurateness for the new NACP and Markus chambers. On the basis of measurements a protocol for the dosimetry of high-energetic electron irradiation has been drawn up. The benefit of this protocol is that all for the reference dosimetry recommended chambers, the cylindrical as well as the plan-parallel chambers, can be calibrated directly by the RIVM. (H.W.). 3 refs.; 3 figs.; 1 tab.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to citation(s) 21915, 22334

22452 (AD-A–214634/8/XAB) **Use of RADFETS (Radiation-Sensitive Field Effect Transistor) in radiation dose measurement: Report on three lots prepared for the US Army. Final report, 16 June 1987-18 September 1989.** Holmes-Siedle, A.G. Radiation Experiments and Monitors, Oxford (UK). Sep 1989. 44p. (REM-FM–89-2). Available from NTIS, PC A03/MF A01.

This final report describes the preparation of experimental RADFET dosimeters prepared by REM, a UK firm. Samples were delivered to the US Army for testing. The object was the evaluation of the Radiation - Sensitive Field Effect Transistor (RADFET) for use in tactical dosimetry systems. Three lots of the new Type TOT500 quadruple - transistor RADFET design were prepared and preliminary evaluations of each lot were made in the UK. A dose range of 5 to 5000 rads (0.05 to 50 Gy) is predicted. Special ceramic packages with a reduced amount of gold in the cavity were used. The zero bias mode, which eliminates batteries from tactical dosimeters, was proved to be useful. The prospects of the RADFET as a practical dosimeter look encouraging.

4404 Well Logging Instrumentation

Refer also to citation(s) 21280, 22450

4406 Optical Instrumentation

Refer also to citation(s) 21533, 21610, 22184, 22275, 22381, 22429, 22485, 22840, 23098, 23099

22453 (CONF-8910197–3) **$Y_1Ba_2Cu_3O_{7-x}$ laser-ablation plume dynamics measurement by nanosecond response ion probe: Comparison with optical measurements.** Mashburn, D.N.; Geohegan, D.B. Oak Ridge National Lab., TN (USA). Nov 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From SPIE symposium on microelectronic integrated processing: growth, monitoring, and control; Santa Clara, CA (USA); 8-13 Oct 1989. Order Number DE90007658. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A family of fast time response ion probes has been developed to study the laser-ablation plume dynamics under $Y_1Ba_2Cu_3O_{7-x}$ film-growth conditions. These probes are useful over a wide range of pressures, distances, laser energies, and energy densities. The ion probe measurements are complemented and corroborated by measurements using spatially and temporally resolved optical emission and absorption spectroscopy. The results confirm a long lived ionized component to the plume and a marked slowing of the plasma front at film deposition pressures and distances. Both the ion probe and spectroscopic techniques show promise as sensitive process monitors for film deposition by laser ablation. 23 refs., 10 figs.

22454 (UCRL–101541) **Low scatter edge blackening compounds for refractive optical elements.** Lewis, I.T. (Perkin-Elmer Corp., Garden Grove, CA (USA)); Telkamp, A.R.; Ledebuhr, A.G. Lawrence Livermore National Lab., CA (USA). 25 Jul 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890836–23: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90008360. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Perkin-Elmer's Applied Optics Operation recently delivered several prototype wide-field-of-view (WFOV), F/2.8, 250 mm efl, near diffraction limited, concentric refractive lenses to Lawrence Livermore National Laboratory (LLNL). In these lenses, special attention was paid to reducing stray light to allow viewing of very dim objects. Because of the very large FOV, the use of a long baffle to eliminate direct illumination of lens edges was not practical. With the existing relatively short baffle design, one-bounce stray light paths off the element edges are possible. The scattering off the inside edges thus had to be kept to an absolute minimum. While common means for blackening the edges of optical elements are easy to apply and quite cost effective for normal lens assemblies, their blackening effect is limited by the Fresnel reflection due to the index of refraction mismatch at the glass boundary. At high angles of incidence, total internal reflection (TIR) might occur ruining the effect of the blackening process. An index-matched absorbing medium applied to the edges of such elements is the most effective approach for reducing the amount of undesired light reflected or scattered off these edges. The presence of such a medium provides an extended path outside the glass boundary in which an absorptive non-scattering dye can be used to eliminate light that might otherwise have propagated to the focal plane. Perkin-Elmer and LLNL undertook a program to develop epoxy-based dye carrier compounds with refractive indices corresponding to the glass types used in the WFOV lens. This program involved the measuring of the refractive index of a number of epoxy compounds and catalysts, the experimental combination of epoxies to match our glass indices, and the identification of a suitable non-scattering absorptive dye. 10 figs., 3 tabs.

22455 (UCRL–101574) **Placement of multiple apertures for imaging telescopes.** Fitch, J.P.; Lawrence, T.W. Lawrence Livermore National Lab., CA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900285–1: SPIE astronomical telescopes and instrumentation for the 21st century symposium, Tucson, AZ (USA), 11-17 Feb 1990).

Order Number DE90006991. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two techniques we have used for determining mirror positions in multiple-aperture telescope arrays are described. Our design criteria is the maximization of the contiguous central core diameter of the optical transfer function for the telescope system. The first technique is applicable to arrays with a relatively small, O(10), number of apertures and is essentially an exhaustive search with a simple in-line test which allows the search space to be "pruned" by an order of magnitude. In the second technique, arrays of a large number of apertures are designed using a fractal approach by recursively combining the results from several array patterns with fewer apertures. Both techniques are demonstrated for one and two dimensional designs and can be extended for higher dimensions if needed. 1 ref., 13 figs.

22456 (UCRL–102525) **Spatial imaging using confocal Fabry-Perot interferometers.** Myers, D.W.; Decker, D.E.; Johnson, M.A.; Mostek, S.D. Lawrence Livermore National Lab., CA (USA). [1990]. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. (CONF-900530–8: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90008363. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A diagnostic imaging package containing confocal Fabry-Perot interferometers is used to provide spatial intensity information for each of several closely spaced wavelength components of a single laser beam. 2 refs., 2 figs.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 21162, 21304, 21442, 22195, 22332, 22502, 22535, 22722, 22736, 22755, 22986

22457 (DOE/ER/14018–1) **[The glow discharge as an atomization and ionization source]: Technical progress report.** Florida Univ., Gainesville, FL (USA). Dept. of Chemistry. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER14018. Order Number DE90007693. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This is to summarize the research progress in this project at the University of Florida over the past 13 months. In keeping with the directions of the Federal Demonstration Project, the report will be brief, presenting an overview of the major findings. We have continued the study of the glow discharge, primarily as an ionization source for elemental analysis. Glow discharge interest continues to grow in the analytical chemistry community as evidenced by the number of special symposia at major conferences, by the new researchers entering the field, and by the introduction of new instrumentation. There is little doubt that glow discharge mass spectrometry, for example, is now a major technique in the elemental analysis of solids.

22458 (ECN–221) **Aspects of accuracy and precision in the determination of As and Sb in biological materials by neutron activation analysis.** Woittiez, J.R.W.; Geusebrock, M. Netherlands Energy Research Foundation, Petten (Netherlands). Aug 1989. 18p. Order Number DE90706034. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Aspects of accuracy and precision on the analysis of As and Sb in biological materials using neutron activation with post-irradiation separation are discussed. The separation technique is based on hydride generation. The average yield is over 98% for As and over 95% for Sb, but differences between samples necessitate a yield determination for each sample. Both radiotracers and reactivation have been applied and their practical use for yield correction is discussed. Under optimized conditions, As in NBS SRM 1577A has been analysed to be 45.5 $\pm$ 0.7 μg/kg (N = 4), while the Sb-content points to 2.3 $\pm$ 1.0 μg/kg (N = 11). 3 figs., 20 refs., 5 tabs.

22459 (INIS-mf–11470) **Application of 1D- and 2D-NMR techniques for the structural studies of glycoprotein-derived carbohydrates.** Breg, J.N. Rijksuniversiteit Utrecht (Netherlands). 6 Mar 1989. 136p. Order Number DE90706035. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI.

The first part of this thesis (Chapters 1 to 4) describe the determination of the primary structure for a large number of oligosaccharide-alditols obtained from bronchial sputum of cystic patients suffering from chronic bronchitis. The second part (Chapters 5 to 8) is devoted to the application of two-dimensional NMR methods for the structural analysis of oligosaccharides. 163 refs., 50 figs., 25 tabs.

22460 (INIS-mf–11546) **Culturated rat cerebral cortex explants and their application in the study of SPECT scan radiopharaceuticals.** Jong, B.M. de. Amsterdam Univ. (Netherlands). 23 Jun 1989. 143p. (In Dutch). Order Number DE90706038. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

In this thesis mechanics that result in the distinct localization of radiopharmaceuticals within the brain have been investigated In order to 'get more insight' in uptake and binding of radiopharmaceuticals bu brain tissue, use has been made of the tissue culture technique. Tissue culture provides the opportunity of doing experiments with brain tissue under stable conditions, in the absence of a blood-brain barrier, and without interference by cerebral blood flow. The present thesis is presented in two sections. The first part focusses on longterm culture of 'organotypic' cerebral neocortex tissue, obtained from neonatal rat brain and explanted into a chemically defined medium. Procedures were developed which enabled culturing of this tissue without the occurrence of central necrosis and with the preservation of a characteristic histiotypic organization. Morphological characteristics of the cultures were described and measured at various ages in vitro. In the second part, the cultures were used to study mechanisms that might contribute to the tissue uptake of radiopharmaceuticals which are in clinical use for SPECT brain imaging. 369 refs., 50 figs., 13 tabs.

22461 (INIS-mf–11555) **Ventilation-perfused studies using SPECT: Quantitative assessment of regional pulmonary function.** Zwijnenburg, A. Amsterdam Univ. (Netherlands). 16 Mar 1989. 98p. Order Number DE90706047. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

A method for the quantitative analysis of ventilation-perfusion SPECT studies is described and an effort is made to evaluate its usefulness. The technical details of the method are described. In the the transaxial reconstructions of the tomographic studies the contour of the lungs is detected and regional values of lung volume, ventilation, perfusion and ventilation-perfusion ratios are calculated. The method is operator independent. The lung volume calculations from the SPECT studies are validated by comparing them with lung volume measurements using the helium dilution technique. A good correlation (r = 0.91) was found between the two volumes. SPECT volume was greater than the volume measured with helium dilution, which was attributed to non-gas-containing structures in the lungs. The use of ventilation-perfusion ratio SPECT is described to evaluate the effect of ionizing radiation on the lungs in patients treated with mantle field irradiation for Hodgkin's disease. Perfusion changes appear as early as 2 months after the start of irradiation. Ventilation changes appear later and relatively minor. No changes are seen outside the radiation portals. The ventilation-perfusion inequality in pulmonary sarcoidosis is treated. It is suggested that the decrease D LCO in these patients may be partly due to an even distribution of ventilation perfusion ratios. An effort is made to establish the properties of a new tracer used for the assessment of the metabolic function of the pulmonary endothelium. The lung uptake of I-123 IMP mimics the distribution of a perfusion tracer and it is suggested that the tracer may be useful for the early detection of pulmonary vascular damage, even when blood flow is still intact. Some aspects of the use of Kr-81m as a ventilation tracer are discussed as well as the effect of noise on Kr-81m SPECT reconstructions. 146 refs., 39 figs., 8 tabs.

22462 (N–90-13449, pp. 92-93) **A four channel He-3 cooled balloon-borne bolometer radiometer.** Meyer, S. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1988. (NASA-CR–184656;JPL-PUBL–88-23;NAS–1.26:184656;CONF-8709487–: Asilomar 3LDR workshop, Asilomar, CA (USA), Sep 1987). In *Report of the Asilomar 3 LDR Workshop*. Available from NTIS, PC A08/MF A01.

A four channel He-3 cooled balloon-borne bolometer radiometer was constructed. The principal goal of the instrument is to measure the anisotropy of the 3 K cosmic background radiation on angular

scales of 4 to 180 deg. The goal is to improve the sensitivity of the measurements to Delta T/T is less than .00001. A secondary goal is to survey the galactic thermal dust emission in the submillimeter range.

22463 (N–90-13761) **Development and characterization of PdCr temperature-compensaated wire resistance strain gage.** Lei, J.F. Sverdrup Technology, Inc., Cleveland, OH (USA). Oct 1989. 9p. (NASA-CR–185153;E–5112;NAS–1.26:185153;CONF-890996–: Sensor's expo '89, Cleveland, OH (USA), 12-14 Sep 1989). Available from NTIS, PC A02/MF A01.

A temperature-compensated resistance static strain gage with potential to be used to 600 C was recently developed. Gages were fabricated from specially developed palladium-13 w/o chromium (Pd-13Cr) wire and platinum (Pt) compensator. When bonded to high temperature Hastelloy X, the apparent strain from room temperature to 600 C was within 400 microstrain for gages with no preheat treatment and within 3500 microstrain for gages with 16 hours prestabilization at 640 C. The apparent strain versus temperature relationship of stabilized PdCr gages were repeatable with the reproducibility within 100 microstrain during three thermal cycles to 600 C and an 11 hours soak at 600 C. The gage fabrication, construction and installation is described. Also, the coating system used for this compensated resistance strain gage is explained. The electrical properties of the strain sensing element and main characteristics of the compensated gage including apparent strain, drift and reproducibility are discussed.

22464 (PB–90-130907/XAB) **Radiometer equation and analysis of systematic errors for the NIST (National Institute of Standards and Technology) automated radiometers. Technical note.** Daywitt, W.C. National Inst. of Standards and Technology (NEL), Boulder, CO (USA). Electromagnetic Fields Div. Mar 1989. 27p. (NIST/TN–1327). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs. as SN003-003-02965-3.

Equations used in the NIST coaxial and waveguide automated radiometers to estimate the noise temperature and associated errors of a single-port noise source are derived in the report. The equations form the foundation upon which the microwave and millimeter-wave noise calibration and special test services are performed. Results from the 1-12 GHz coaxial radiometer are presented.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 21785, 22275

22465 (LA-UR–90-650) **Finite element models to predict the structural response of 120-mm sabot/rods during launch.** Rabern, D.A. (Los Alamos National Lab., NM (USA)); Bannister, K.A. Los Alamos National Lab., NM (USA). [1990]. 22p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9005118–1: U.S. Army symposium on gun dynamics, Tamiment, PA (USA), 14-17 May 1990). Order Number DE90007497. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Numerical modeling techniques in two- and three-dimensions were used to predict the structural and mechanical behavior of sabot/rod systems while inbore and just after muzzle exit. Three-dimensional transient numerical simulations were used to predict the rod deformations and states of stress and strain caused by axial and lateral accelerations during launch. The numerical models include the launch tube, recoil motion, and sabot/rod system modeled as it transits the launch tube and exits. The simulated rod leaves the muzzle of the gun, and exit parameters, including transverse displacement, transverse velocity, pitch, and pitch rate are extracted from the analysis results. Results from the inbore numerical simulations were compared with previous full-scale experiments. The results of the comparisons indicated a predictive capability to model inbore three-dimensional phenomena. Two-dimensional analyses were used to model details of the structural behavior caused by the axial load environment. Methodology and results are presented for several launch environments. 7 refs., 16 figs., 5 tabs.

22466 (M–277) **The Janus system manager's guide: Version 4.04.** Pimper, J.E.; Calloway, D.R.; Elko, S.D.; Rhodes, J.J.; Uzelac, M.J.; Wilson, J. Lawrence Livermore National Lab., CA (USA). 1 Sep 1989. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008258. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This guide describes the steps necessary to fully install and maintain the Janus combat simulation on a Digital Equipment Corp. (DEC) VAX computer. It is designed to familiarize System Managers with the operational concepts associated with the Janus package. This guide will not describe how to run the model itself. For information regarding the Janus simulation, or its associated utilities, please refer to the Janus documentation set.

22467 (M–278) **The Janus simulation guide: Version 4.04.** Pimper, J.E.; Calloway, D.R.; Elko, S.D.; Rhodes, J.J.; Uzelac, M.J.; Wilson, J. Lawrence Livermore National Lab., CA (USA). 1 Sep 1989. 119p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008256. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report is a users guide to the Janus simulation program. Janus simulation program simulates warfare strategy and military tactics. (LSP)

22468 (UCRL–102995) **Computer simulations and experiments to study the fracture of rods by flying plates.** Reaugh, J.E.; Wilkins, M.L. Lawrence Livermore National Lab., CA (USA). 8 Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005122–1: 1990 conference on the application of 3-D hydrocodes to armor/anti-armor problems, Aberdeen Proving Ground, MD (USA), 7-11 May 1990). Order Number DE90008308. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have used HEMP3D to study the interaction of flying plates with a tungsten-alloy rod. HEMP3D is a three-dimensional elastic-plastic-hydrodynamic Lagrangian finite-difference computer simulation program with sliding interfaces. We have implemented a fracture model that treats both the initiation and growth of fractures. This model does not require the prespecification of fracture surfaces. Comparison of the results of computer simulations with a limited number of experiments indicated that the computer simulations were in good agreement with experiment as to the number and size of the broken pieces. We subsequently performed a number of computer simulations varying the mass and velocity of the flying plates. We compare the results of these simulations at a fixed time after impact to obtain the relative effectiveness of a given flying plate configuration. A configuration that produces many fragments and rotates them all out of alignment is given high ranking. It is intuitively likely that bigger and faster plates would rank higher than smaller, slower ones. In the experiments, the plates are accelerated by explosive. We have imposed a constraint on the flying plates that corresponds to a fixed amount of explosive, so the more massive plates move more slowly. 9 refs., 2 figs., 1 tab.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 22195, 22217, 22329, 22476, 22482

22469 (MLM–3628-OP) **Ignition of HMX [cyclotetramethylenetetranitramine] using low energy laser diodes.** Ewick, D.W.; Beckman, T.M.; Holy, J.A.; Thorpe, R. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-900254–2: 14. symposium on explosives and pyrotechnics, Burlingame, CA (USA), 13-15 Feb 1990). Order Number DE90007637. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The sensitivity of blends of cyclotetramethylenetetranitramine (HMX) with carbon black and graphite to laser diode ignition was investigated. Using a 100-μm optical fiber, a blend of 15,700 cm^2/g HMX with 3% carbon black by weight was the most sensitive material tested, with a threshold of 72 mW. Pure, or undoped, HMX could not be ignited using 10 ms laser diode pulses with power levels up to 880 mW. In general, the HMX/carbon black blends

were more sensitive than the HMX/graphite blends. HMX specific surface area also had a significant effect on sensitivity. Doubling the spot size increased the ignition threshold by a factor of approximately 2.7. Increasing the pulse width from 10 to 100 ms did not significantly reduce the laser diode power required for ignition. Photoacoustic spectrometer was used to compare the absorption characteristics of the HMX blends. The absorption spectra obtained correlated well with the sensitivity test data. 11 refs., 5 figs., 3 tabs.

22470 (SAND–90-0259C) **Pyrotechnic device technology.** Wilcox, P.D. Sandia National Labs., Albuquerque, NM (USA). [1989]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8909113–7: 14. international pyrotechnics seminar, Jersey (UK), 18-22 Sep 1989). Order Number DE90007683. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This talk was given at the 14th International Pyrotechnic Seminar on September 21, 1989, in Jersey, United Kingdom, as one of two plenary lectures. It briefly surveys the current technology of pyrotechnic devices and examines trends for the future. The "pyrotechnic" can have several meanings. In this talk, "pyrotechnic devices" are devices in which porous materials undergo reduction-oxidation reactions and produce useful products. The pyrotechnic materials are generally fuel-oxidizer systems without binders, in contrast to primary or secondary explosives or propellants. The word "pyrotechnic" is often used to include explosive, squib, propellant, or other ordnance type devices, especially in the European community. The major need for pyrotechnic devices has always been military and defense; however, as technology advances, the civilian uses of pyrotechnics will continue to grow. If every automobile had a pyrotechnic device to trigger its air or crash bag, that application alone would mean millions of devices per year. Applications in safety, fire fighting, law enforcement, and other commercial applications are likely to increase due to the increased capability of pyrotechnic devices and the integration of such devices in system designs. 2 refs., 56 figs.

22471 (UCID–21864) **High-Explosives Applications Facility (HEAF): Final Safety Analysis Report (FSAR).** Morse, J.L.; Weingart, R.C. (comps.). Lawrence Livermore National Lab., CA (USA). Mar 1989. 300p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008122. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This Safety Analysis Report (SAR) reviews the safety and environmental aspects of the High Explosives Applications Facility (HEAF). Topics covered include the site selected for the HEAF, safety design criteria, operations planned within the facility, and the safety and environmental analyses performed on this project to date. Provided in the "Summary" section is a review of hazards and the analyses, conclusions, and operating limits developed in this SAR. Appendices provide supporting documents relating to this SAR. This SAR is required by the LLNL Health and Safety Manual and DOE Order 5481.1B[2] to document the safety analysis efforts, The SAR was assembled by the Hazards Control Department, B-Division, and HEAF project personnel. This document was reviewed by B Division, the Chemistry Department, the Hazards Control Department, the Laboratory Associate Director for Administration and Operations, and the Associate Directors ultimately responsible for HEAF operations.

22472 (UCRL–102632) **Computed tomography of PBX9502 high explosives at Lawrence Livermore National Laboratory.** Martz, H.E.; Roberson, G.P.; Skeate, M.F.; Schneberk, D.J.; Azevedo, S.G.; Lynch, S.K. Lawrence Livermore National Lab., CA (USA). [1989]. 57p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8906139–2: 31. weapons agencies nondestructive testing organization, Kansas City, MO (USA), 5-9 Jun 1989). Order Number DE90008305. Available from NTIS, PC A04/MF A01 - OSTI.

X-ray computed tomography (CAT or CT) is an advanced imaging technique which provides cross-sectional views of materials, components and assemblies for industrial nondestructive evaluation. The Lawrence Livermore National Laboratory (LLNL) and the Mason & Hanger-Silas Mason Co., Pantex Plant are cooperating to examine the use of CT Technology to inspect high-explosive pressings. The goal of this joint project is to study high-explosive pressings using computed tomography scanners, to provide a foundation for the development of industrial CT systems, and to work with the private sector on the design and implementation of an automated CT inspection system to be used in the manufacturing process of high explosives (HE) at the Pantex Plant. The early detection of bad HE pressings will reduce the cost and improve the safety of the high explosives production cycle. At present, samples are randomly selected from a pressing lot and are taken and destructively core sampled to obtain an estimate of the internal density gradients. CT holds the possibility of providing a technology base for a high-explosives inspection system with a probability of detection of density variations and voids, as good as or better than present techniques. In addition, CT can be fully automated to allow for a 100% sample inspection. LLNL has the advantage of several different in-house built CT systems to bring to bear on the inspection of high explosives. [MAR88, AZE88, & MAR89] A preliminary study was performed to evaluate the LLNL CT scanners and prove the principles associated with CT on small PBX9502 high-explosive samples. [MAR89a] The presentation at the meeting (Appendix A) summarized the results obtained, and introduced the capabilities of our CT scanners. 10 refs., 24 figs., 1 tab.

22473 **Advances in explosively formed fuse opening switches.** Goforth, J.H. (Los Alamos National Lab., NM (USA)); Caird, R.S.; Greene, A.E.; Lindemuth, I.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors report the development of explosively formed fuses along two separate lines. One design, has now been demonstrated to conduct a 9.5 MA 350 μs risetime pulse and interrupt it in 1.2 μs. Ultimately, this design should operate at up to 15MA with 20-nH loads. A second design with enhanced performance characteristics is being examined and will be tested on a small scale. This design includes opening switch inductance as part of the inductive store and, as a result, should have shorter pulse transfer times and should be able to be scaled to handle currents up to ~25 MA with 20 nH loads.

4502 Nuclear Explosions and Explosives

22474 (AD-A–214875/7/XAB) **STREAK damping. Technical report.** Baker, J.; Peyton, S.; Freiberg, H. S-Cubed, San Diego, CA (USA). 1 Dec 1989. 115p. (SSS-DTR–89-10483). Available from NTIS, PC A06/MF A01.

This report documents a study aimed at improving the damping in STREAK. A form and value for an artificial viscosity is recommended which appears to control ringing and overshoots without overdamping.

22475 (DOE/NV–337) **Tunnel Review Executive Committee report of programs conducted in the Nevada Test Site tunnel complex.** Herbert, E.C. (Holmes and Narver, Inc., Las Vegas, NV (USA)); Holmes, R.C. USDOE Nevada Operations Office, Las Vegas, NV (USA). Feb 1990. 133p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008370. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

In July 1989, the Manager, Nevada Operations Office, directed that a review be conducted of work in tunnel operations performed in support of the Defense Nuclear Agency (DNA) to ensure that responsibilities and authorities were well understood. The Tunnel Review Executive Committee, an ad hoc body, was established to perform the review. Over a period of six months, the Committee organized the review, conducted interviews, and wrote this report. The Committee defined separate phases of work in the tunnels progressing from site characterization through construction, test execution, and reentry. The Committee then developed a list of questions to be answered by review participants concerning their activities in each phase. DISKO ELM, the most recent tunnel event, was used as a model to develop a list of organizations and related operations for review. All principal participants in DISKO ELM and some of the lesser participants (22 in all) prepared and

presented briefings to the Committee. These briefings followed the outline of phases and topics provided by the Committee. An additional 12 organizations provided written statements of their participation following the same outline.

22476 (UCID–20622-89-2) **Chemistry and materials science research report: Second half FY89.** Lawrence Livermore National Lab., CA (USA). 19 Jan 1990. 88p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008298. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The research reported here in summary form was conducted under the auspices of Weapons-Supporting Research (WSR) and Institutional Research and Development (IR&D). The period covered is the second half of FY89. WSR is the principal source of discretionary funds to support fundamental research in the Chemistry & Materials Science Department (C&MS). The purpose of WSR is to provide the scientific and technical base that is required in the longer term for success of the Weapons Program. Administratively, WSR is organized into block-funded programs ("thrust areas") and a few smaller projects led by individual investigators. A thrust area is designed to provide a coordinated approach to a focused scientific or technological area and typically involves several senior scientists. The results reported here are for work in progress; thus, they may be preliminary, fragmentary, or incomplete.

22477 (UCRL–100934) **Residual stresses calculated using an effective stress model.** Attia, A.V.; Swift, R.P. Lawrence Livermore National Lab., CA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909163–14: 5. symposium on containment of underground nuclear detonations, Santa Barbara, CA (USA), 19-21 Sep 1989). Order Number DE90008364. Available from NTIS, PC A02/MF A01 - OSTI.

The effect of water content in saturated porous rocks is of interest in assessing the transient rock response to underground nuclear explosions. The interaction of the water-filled pores with the rock matrix is represented in an "effective stress" constitutive model. Separate equations of state are used for the rock and the water. The effective stress governs the failure response of the rock. Effect of water drainage is assumed to be negligible during early transient response to shock loading of interest. For comparison, a simpler constitutive model is also described. This model represents the saturated porous rock as a homogeneous mixture, using a single equation of state. The associated total homogeneous stress governs the failure response. These models have been incorporated into the 2D explicit finite-element code DYNA-2D. Stress fields around the explosively generated cavity are calculated for a particular event using the "Effective Stress" and the "Total (homogenizes) Stress" models, and results are discussed. 6 refs., 12 figs., 2 tabs.

22478 (UCRL–100962) **Recent nuclear cavity pressure measurements.** Hudson, B. (Lawrence Livermore National Lab., CA (USA)): Stubbs, T.; Nilson, R.; Peterson, E. Lawrence Livermore National Lab., CA (USA). Sep 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909163–13: 5. symposium on containment of underground nuclear detonations, Santa Barbara, CA (USA), 19-21 Sep 1989). Order Number DE90008362. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An underground nuclear test is typically conducted in an emplacement hole hundreds of metres deep that has been back-filled with sand gravel and concrete plugs. These plugs, which vary in thickness and strength, serve not only to prevent radioactive material from reaching the surface but also, ideally, to constrain it to a region near the explosion cavity. When we determine the appropriate depth of burial (DOB) for a device, we have to make it shallow enough to be economical but deep enough to reasonably ensure containment given the expected yield of the device and the particular geology of the hole. To do this, we have developed sophisticated computer models that consider each site's geologic structure and physical properties to predict explosion effects such as ground motion, confining stresses around the cavity, and cavity pressure. However, to be able to assess the performance and relative accuracy of these computational models, we must develop a data base of the measured values for each of these effects that can be compared with predictions. This report discusses pressure measurements and devices at the Cornucopia, Mission Ghost and Rhyolite Events.

4503 Nuclear Explosion Detection

22479 (AD-A–214595/1/XAB) **Comparison of the spectral characteristics of nuclear explosions detonated below and above the water table. Report for March 1988-February 1989.** Gupta, I.N.; Lynnes, C.S.; Chan, W.W.; Wagner, R.A. Teledyne Geotech, Alexandria, VA (USA). Alexandria Labs. Apr 1989. 79p. (TGAL–89-04). Available from NTIS, PC A05/MF A01.

A comparison of the spectra of nuclear shots detonated below and above the water table (WT) is made by analysis of mostly the regional phase Pn recorded at two common stations. Parameters derived from each record include estimates of corner frequency F_c and the low-frequency spectral level A_0, after the spectra have been corrected for the effects of spatial attenuation. The time-domain measurements of A/T, a measure of m_b, are also made on each observed record. Results from 22 Nevada Test Site (NTS) shots recorded at the DWWSSN digital station, JAS, indicate that plots of f_c versus A_0 show some separation between the below and above WT populations whereas plots of f_c versus A/T show no significant separation. For a fixed yield, f_c for shots below and above WT are nearly indistinguishable whereas both A_0 and A/T are considerably larger for shots below WT than for those above WT, presumably due to improved source coupling of shots in water saturated environment. A comparison of yields estimated from A_0, A/T, A_0 combined with f_c, and A/T combined with f sub c demonstrates that substantially more precise yield determinations can be made if it is known whether the shot was detonated above or below WT. Results from the analysis of 17 NTS shots recorded at the RSTN station, RSSD are generally not as well defined but appear similar to those from the JAS recordings. The largest difference between the below and above WT shots of a given yield lies in their low-frequency spectral level and, to a slightly smaller extent, in their M_b values.

22480 (SAND–89-2262C) **Seismic data processing using digital signal analysis techniques.** Phillips, J.S.; Stearns, S.D.; Long, J.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900599–2: 36. ISA international instrumentation symposium, Denver, CO (USA), 6-10 May 1990). Order Number DE90006185. Available from NTIS, PC A02/MF A01 - OSTI.

This paper summarizes some of the unique features of the digital signal analysis techniques used to process seismic acceleration data and provides examples of the results. First an overall description of the automated package is presented. The package consists of several programs and routines that process the acceleration waveforms to enhance signal-to-noise ratio, filter, integrate, perform spectral computations, etc. Next, we discuss some specific problems and solutions associated with integrating the acceleration data twice to produce displacement waveforms and hodographs. A frequency domain integration scheme is described. Finally, we describe a system for archiving the inputs and outputs of the automated package. The archives provide an extensive data base of ground motions from underground nuclear explosions. 7 refs., 8 figs.

22481 (SAND–89-2293C) **A linear filtering technique for removal of low-frequency noise.** Long, J.W.; Stearns, S.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900599–1: 36. ISA international instrumentation symposium, Denver, CO (USA), 6-10 May 1990). Order Number DE90006183. Available from NTIS, PC A02/MF A01 - OSTI.

In an analog recording of an electronic pulse, the baseline of the recording can shift during the test. Before accurate processing can be performed on the recorded pulse, the baseline must be identified and adjusted so deflections may be measured from a zero baseline. A simple high-pass filtering method to identify and remove the baseline deviations has been devised and implemented. The

primary advantages of this method are that little or no lead time is needed to initialize the filter, and data which cannot be processed with standard filters because of problems caused by filter response, may be successfully processed with this method. This paper explains how the baseline is identified and removed and provides examples using ground-motion accelerations recorded during underground nuclear tests at Nevada Test Site. 3 refs., 6 figs., 1 tab.

4504 Nuclear and Radiological Warfare

22482 (AD-A–215037/3/XAB) **Preliminary report on the feasibility of high-power electronic warfare (EW) using explosive energy sources.** Clark, G.A.; Sadedin, D.R. Materials Research Labs., Ascot Vale (Australia). Mar 1989. 27p. (MRL-TR–89-3). Available from NTIS, PC A03/MF A01.

Electronic warfare (EW) is an extremely important element in modern military conflicts. One form of EW involves jamming where, in general, the effectiveness increases with the power level that can be employed. Within the constraints of the upper power limit it would seem to be possible to raise power levels to the point where components are damaged. The required high powers for such EW functions can be produced by compact magnetohydrodynamic (MHD) power sources using fuels such as explosives or propellants. Some indicative applications are discussed and areas for research are identified.

22483 (AD-A–955741/4/XAB) **Regional rivalries and nuclear responses. Volume 2. The south korean case: A nuclear weapons program embedded in an environment of great power concerns. sanitized. Final report, 8 November 1976-28 February 1978.** Jack, B.; Agmon, M.; Head, S.L.; McGarvey, D.; Rowen, B. Pan Heuristics, Los Angeles, CA (USA). 28 Feb 1978. 152p. (PH–78-02-794-43-V-2). Available from NTIS, PC A08/MF A01.

No abstract available.

4505 Strategic Defense Initiative

Refer also to citation(s) 22035, 22037, 23145

22484 (AD-A–214874/0/XAB) **Development of advanced WTA (Weapon Target Assignment) algorithms for parallel processing. Final report.** Castanon, D.A. ALPHATECH, Inc., Burlington, MA (USA). Oct 1989. 89p. (TR–457). Available from NTIS, PC A05/MF A01.

The objective of weapon-target assignment (WTA) in a ballistic missile defense (BMD) system is to determine how defensive weapons should be assigned to boosters and reentry vehicles in order to maximize the survival of assets belonging to the U.S. and allied countries. The implied optimization problem requires consideration of a large number of potential weapon target assignments in order to select the most effective combination of assignments. The resulting WTA optimization problems are among the most complex encountered in mathematical programming. Indeed, simple versions of the WTA problem have been shown to be NP-complete, implying that the computations required achieve optimal solutions grow exponentially with the numbers of weapons and targets considered in the solution. The computational complexity of the WTA problem has motivated the development of heuristic algorithms that are not altogether satisfactory for use in Strategic Defense Systems (SDS). Some special cases of the WTA problem are not NP-complete and can be solved using standard optimization algorithms such as linear programming and maximum-marginal-return algorithms; these algorithms enjoy low computational requirements and therefore have been adopted as heuristics for solving more general WTA problems. However, experimental studies have demonstrated that these heuristic algorithms lead to significantly suboptimal solutions for certain scenarios.

22485 (ORNL/OMIS–90/1) **The Survivable Optics MODIL [Manufacturing Operations Development and Integration Laboratory]: Guidelines for forming R and D consortia from the theory of clubs.** Katzman, M.T.; Jones, D.W. Oak Ridge National Lab., TN (USA). Mar 1990. 42p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90008131. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Under the aegis of SDIO, a Survivable Optics Manufacturing Operations Development and Integration Laboratory (MODIL) has been established at ORNL. The purposes of the MODIL are to achieve order-of-magnitude cost reductions in the manufacture of optical components and to contribute to the revitalization of the American optics industry. The MODIL is a federal laboratory-university-industry consortium that sponsors manufacturing R&D and aims to transfer this technology to the domestic optics industry by utilizing a manufacturing test bed at ORNL. The purposes of this analysis are: (1) to identify the types of firms that would make the best members of the MODIL, (2) to identify the conditions under which private firms would be willing to participate in the consortium R&D, and (3) to indicate conditions under which firms could supplant the Federal government as the source of funding. The conceptual approach is derived from the economic theory of clubs. A review of the literature on R&D consortia in the United States and Japan and informal interviews with 18 industrial participants in the MODIL provide the empirical basis for conclusions and recommendations. 41 refs.

22486 (UCRL–99967-Rev.1) **Measurement of the stimulated thermal Rayleigh scattering instability: Revision 1.** Karr, T.J.; Rushford, M.C.; Murray, J.R.; Morris, J.R. Lawrence Livermore National Lab., CA (USA). Jan 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–12-Rev.1: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90007849. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report the first clear experimental demonstration of large amplification of small-scale spatial perturbations by stimulated thermal Rayleigh scattering (STRS) of a CW laser beam propagating through an absorbing medium in a context normally associated with thermal blooming. A single-mode argon-ion laser beam with λ = 488 nm was propagated vertically downward through a 1.2 m cell filled with CCl_4 that was doped with an absorber to have optical depths in the range 0.5-2.3. A shear-plate interferometer near the cell input generated the perturbation. Fringe growth was rapid and visually obvious, as was competing growth from dust specks, etc. The measured growth rate is in good agreement with the asymptotic rate from analytic STRS theory. 26 refs., 4 figs., 2 tabs.

4506 Chemical and Biological

22487 (AD-A–214475/6/XAB) **Effect of anticholinesterase agents on airway epithelial function. Annual report, 15 July 1888-14 August 1989.** Marin, M.G. Rochester Univ., NY (USA). 15 Sep 1989. 29p. Available from NTIS, PC A03/MF A01.

Irreversible anticholinesterase compounds have potential serious health effects when employed as chemical warfare agents. Intoxication with these agents will cause an accumulation of acetylcholine at nerve muscle and nerve-gland junctions. Because tracheal glands have rich cholinergic innervation, we hypothesized that exposure to anticholinesterase agents, such as soman, would stimulate glandular secretion. This would cause pathological changes in the important lung defense mechanism of mucociliary clearance. Initial work on this contract revealed a dose-related increase in mucociliary transport in the ferret in response to soman. This effect could be inhibited by atropine but not by pralidoxime. The investigation described in this report relates to the effects of soman and its antidotes on glycoconjugate secretion of ferret trachea in vitro.

22488 (AD-A–214699/1/XAB) **Workshop on problems in chemical toxicology. Final report, 19-20 June 1980.** Lindstrom, R.E. Connecticut Univ., Storrs, CT (USA). 20 Jun 1980. 111p. Available from NTIS, PC A06/MF A01.

The bulk of the material in this report was transcribed from the proceedings of a two-day conference on biological aspects of chemical defense. In the meeting, six representatives from the Department of Defense exchanged views on the subjects with an equal number of civilian scientists whose scholarly interests touch on various aspects of the overall chemical problem.

22489 (AD-A–214763/5/XAB) **Fortran program for calculating chemical hazards using the NATO (North Atlantic Treaty Organization) STANAG 2103/ATP-45 algorithm. Memorandum report.** Mellsen, S.B. Defence Research Establishment Suffield, Ralston, AB (Canada). Oct 1989. 34p. (DRES–1275). Available from NTIS, PC A03/MF A01.

The Military Agency for Standardization of the North Atlantic Treaty Organization has issued a draft for the algorithm to be used in calculating the maximum downwind hazard distances after attacks with chemical agents. The purpose of this report is to describe a computer program written in Microsoft FORTRAN Version 4.1 to apply the algorithm to calculate a set of sample results for dispersion over both land and sea for all atmospheric stability categories. Another purpose is to present the results in graphical form for convenient use. The validity of the algorithms is not appraised herein, but the program and results provided can be used for familiarization and as aids in improving the program written for an IBM compatible personal computer. It applies the algorithms of ATP 45 to give quick and accurate calculations for distances up to ten kilometers, under all wind speeds and stability categories, and for all but the lowest wind speed in a very stable atmosphere, for distances up to forty kilometers.

22490 (AD-A–214803/9/XAB) **Molecular probes for elucidating mechanisms of action of chemical threat agents. Annual report, 15 February 1988-14 February 1989.** Wiley, J.C.; Uchic, J.T.; Greenwald, S. Chemsyn Science Labs., Lenexa, KS (USA). Nov 1989. 63p. Available from NTIS, PC A04/MF A01.

This report describes the preparation of the following compounds of interest to the U.S. Army Medical Institute of Chemical Defense: 10R-(+)- and 10S-(-)-physostigmine-d3 (1-methyl-d3), sodium ethanethiosulfate, sodium propanethiosulfate, 2-aminoethanethiosulfate, 3-aminopropanethiosulfate, and 4-aminobutanethiosulfate. In addition, progress towards the synthesis of HLO-7 and an HLO-7 congener as well as 10R-(+)- and 10S-(-)-(^{14}C)physostigmine is documented.

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 22552, 22781

22491 (DOE/EH–0125-Vol.2) **Environmental audit manual: Volume 2.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). Office of Environmental Audit. Jan 1990. 531p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008116. Available from NTIS, PC A23/MF A01 - OSTI.

The primary purpose of this manual is to provide a guide upon which an environmental regulatory compliance audit, assessment, or appraisal of a DOE facility can be conducted, and to ensure that all aspects of a particular regulatory area are adequately and consistently covered. In addition, this audit manual provides lines of inquiry to assess a facility's adherence to environmental best management practices (BMPs). The protocols are in a format such that the results and observations of an audit can be documented and recorded. The ultimate objectives of the use of this manual are to document a facility's compliance with environmental laws and regulations, identify areas of potential noncompliance, and plan for corrective action. Although this manual has been developed by a DOE Headquarters entity, it has been designed for use at all levels within DOE.

22492 (DOE/EH–0125-Vol.3) **Environmental audit manual: Volume 3.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). Office of Environmental Audit. Jan 1990. 437p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008117. Available from NTIS, PC A19/MF A01 - OSTI.

The primary purpose of this manual is to provide a guide upon which an environmental regulatory compliance audit, assessment, or appraisal of a DOE facility can be conducted, and to ensure that all aspects of a particular regulatory area are adequately and consistently covered. In addition, this audit manual provides lines of inquiry to assess a facility's adherence to environmental best management practices (BMPs). The protocols are in a format such that the results and observations of an audit can be documented and recorded. The ultimate objectives of the use of this manual are to document a facility's compliance with environmental laws and regulations, identify areas of potential noncompliance, and plan for corrective action. Although this manual has been developed by a DOE Headquarters entity, it has been designed for use at all levels within DOE.

22493 (PNL-MA–580) **Surface environmental surveillance procedures manual: PNL administrative/technical procedures.** Hanf, R.W.; Dirkes, R.L. (eds.). Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 150p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90007682. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Surface Environmental Monitoring Project is maintained by the Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute for the US Department of Energy (DOE). Environmental monitoring data provide a historical record of the levels of radionuclides and radiation present in the Hanford environs as a result of natural sources, worldwide fallout, and Hanford operations. In addition, the data are used in assessing the impact of site operations, demonstrating compliance with applicable guidelines, and verifying the adequacy of the containment and effluent control systems.

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 21155, 21159, 21170, 21516, 21517, 21519, 21540, 21541, 21542, 21543, 21544, 21545, 21546, 21592, 21593, 21602, 21627, 21633, 21664, 21666, 21743, 21844, 21894, 21896, 21901, 21926, 21963, 21969, 22051, 22052, 22054, 22072, 22076, 22203, 22493, 22541, 22555, 22585, 22607, 22620, 22626, 22627, 22658, 22693, 22699, 22703, 22705, 22733, 22734, 22767, 22840

22494 (AD-A–214602/5/XAB) **Reactions of atmospheric species with clean and H, C, and O implanted species. Final report, 1 April 1986-15 July 1989.** Rabalais, J.W. Houston Univ., TX (USA). Dept. of Chemistry. 27 Jul 1989. 131p. Available from NTIS, PC A07/MF A01.

The interactions of low-energy ions with surfaces were studied using surface-science techniques. The energy range studied is from about 1 eV-5 keV, the ions involved are rare gas ions (He(+), Ne(+), Ar(+)) and reactive ions such as N(+)2, N(+), C(+), CO(+), and O(+), and the surfaces included compounds such as K2TiF6, K2NbF7, K2TaF7, and boron nitride (BN) and elemental materials such as graphite, gold, magnesium, nickel, boron, Si(100), and W(211). The phenomena investigated included scattering, recoiling, ion-induced surface damage (decomposition, oxidation, nitridation, chemisorption), inelastic collisions with emission of photons and electrons, scattered and recoiled ion fractions, collisional dissociation, and the dynamics of low-energy collisions. The results are contained in six scientific publications in refereed journals.

22495 (BNL–43838) **Cloud albedo and climate perturbations due to anthropogenic sulfate.** Schwartz, S.E. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900173–1: Global Modeling of Atmospheric Chemistry (GLOMAC) workshop, Schloss Ringberg (Germany, F.R.), 28 Jan - 2 feb 1990). Order Number DE90007674. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the climate response to cloud albedo perturbation and the climate response to global CO_2 increase. Despite strong theoretical underpinning for the belief that increases in the concentrations of CO_2 and other "greenhouse" gases will lead to increased global mean temperature, there is no convincing empirical link between changes in radiative forcing and changes in the earth climate. It has been suggested that sulfate aerosol arising from SO_2 emissions associated with fossil fuel combustion may give rise to an enhancement in cloud albedo that results in a perturbation of radiative forcing comparable in magnitude to that of fossil-fuel CO_2, but opposite sign. 37 refs., 10 figs.

22496 (CEGB-RD-L-3481/P89) **Modelling airborne dispersion of coarse particulate material.** Apsley, D.D. Central Electricity Research Labs., Leatherhead (UK). Mar 1989. 32p. (ODMWG/P-(89)1). Order Number DE90619479. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Methods of modelling the airborne dispersion and deposition of coarse particulates are presented, with the emphasis on the heavy particles identified as possible constituents of releases from damaged AGR fuel. The first part of this report establishes the physical characteristics of the irradiated particulate in airborne emissions from AGR stations. The second part is less specific and describes procedures for extending current dispersion/deposition models to incorporate a coarse particulate component: the adjustment to plume spread parameters, dispersion from elevated sources and dispersion in conjunction with building effects and plume rise. (author).

22497 (DLR-FB-89-61) **Retrieval of wind fields from Doppler measurements of a single radar and application on a cold front with narrow rain band.** Hagen, M. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany, F.R.). Inst. fuer Physik der Atmosphaere). Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Muenchen Univ. (Germany, F.R.). Fakultaet fuer Physik. 1989. 112p. (In German). Order Number DE90759539. Available from NTIS (US Sales Only), PC A06/MF A01; OSIT; INIS.

A method is developed for the retrieval of the horizontal wind vector from Doppler data of a single weather radar. For a horizontal resolution of about 5 km, the accuracy of this method is about 2-5 m/s. This method is applicable for studies of mesoscale phenomena within stratiform precipitation. A cold front with a narrow rainband is studied by this method and additional measurements systems. The wavelike structure of the rainband is caused by windshear and stratification within the frontal zone. The cold front passes the Alpine foreland undisturbed, and is retarded by the main ridge of the Alps for several hours. When reaching the Alps, the prefrontal wind field is modified significantly. The speed of the flow is reduced with a simultaneous increase in the cross-flow circulation. (orig.) With 51 figs., 5 tabs., 72 refs.

22498 (DOE/ER-0441) **Atmospheric Radiation Measurement Program Plan.** USDOE Office of Energy Research, Washington, DC (USA). Atmospheric and Climate Research Div. Feb 1990. 116p. Sponsored by U.S. DOE Energy Research. Order Number DE90008108. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

In order to understand energy's role in anthropogenic global climate change, significant reliance is being placed on General Circulation Models (GCMs). A major goal of the Department is to foster the development of GCMs capable of predicting the timing and magnitude of greenhouse gas-induced global warming and the regional effects of such warming. DOE research has revealed that cloud radiative feedback is the single most important effect determining the magnitude of possible climate responses to human activity. However, cloud radiative forcing and feedbacks are not understood at the levels needed for reliable climate prediction. The Atmospheric Radiation Measurement (ARM) Program will contribute to the DOE goal by improving the treatment of cloud radiative forcing and feedbacks in GCMs. Two issues will be addressed: the radiation budget and its spectral dependence and the radiative and other properties of clouds. Understanding cloud properties and how to predict them is critical because cloud properties may very well change as climate changes. The experimental objective of the ARM Program is to characterize empirically the radiative processes in the Earth's atmosphere with improved resolution and accuracy. A key to this characterization is the effective treatment of cloud formation and cloud properties in GCMs. Through this characterization of radiative properties, it will be possible to understand both the forcing and feedback effects. GCM modelers will then be able to better identify the best approaches to improved parameterizations of radiative transfer effects. This is expected to greatly improve the accuracy of long-term, GCM predictions and the efficacy of those predictions at the important regional scale, as the research community and DOE attempt to understand the effects of greenhouse gas emissions on the Earth's climate. 153 refs., 24 figs., 6 tabs.

22499 (DOE/ER-0442) **Atmospheric Radiation Measurement Program plan: Executive Summary.** USDOE Office of Energy Research, Washington, DC (USA). Atmospheric and Climate Research Div. Feb 1990. 19p. Sponsored by U.S. DOE Energy Research. Order Number DE90006349. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In order to understand energy's role in anthropogenic global climate change, significant reliance is being placed on General Circulation Models (GCMs). A major goal is to foster the development of GCMs capable of predicting the timing and magnitude of greenhouse gas-induced global warming and the regional effects of such warming. The Atmospheric Radiation Measurement (ARM) Program will contribute to the Department of Energy goal by improving the treatment of cloud radiative forcing and feedbacks in GCMs. Two issues will be addressed: the radiation budget and its spectral dependence and the radiative and other properties of clouds. The experimental objective of the ARM Program is to characterize empirically the radiative processes in the Earth's atmosphere with improved resolution and accuracy. A key to this characterization is the effective treatment of cloud formation and cloud properties in GCMs. Through this characterization of radiative properties, it will be possible to understand both the forcing and feedback effects. 19 refs., 4 figs., 2 tabs.

22500 (DOE/ER/60312-3) **Air pollution-caused changes in photosynthesis: Effects on plant growth and rhizosphere functions: Final report.** Winner, W.E. (Oregon State Univ., Corvallis, OR (USA). Dept. of General Science); Antibus, R.K.; Linkins, A.E. Oregon State Univ., Corvallis, OR (USA). Dept. of General Science. Feb 1990. 70p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER60312. Order Number DE90007184. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The relationships between plants, soil nutrient status, and rhizosphere symbionts were probed using ozone (O_3), a commonly occurring air pollutant, as an above-ground stress to alter carbon gain. Laboratory experiments were designed to examine O_3 effects on: (1) tree species grown at varying nutrient levels, (2) plants in symbiosis with a dinitrogen-fixing symbiont, (3) plants in symbiosis with mycorrhizal fungi, and (4) plants having both a dinitrogen-fixing symbiont and mycorrhizae. Photosynthesis measurements and growth analysis were applied to detect O_3 effects on plant carbon gain and allocation, respectively. Stable carbon isotope ratios were analyzed as a means of integrating effects of O_3 on gas exchange of leaves over the life of the plant. Transmission electron microscopy detected alterations in plant root cells symbiotic with dinitrogen-fixing bacteria caused by ozone. To better understand the relationship between host plant and mycorrhizal fungi, studies were conducted on utilization of carbohydrate by ectomycorrhizal fungi and metabolism of ectomycorrhizal fungi and roots. Taken together, these studies provide new information on metabolic relationships of plants and symbionts and the effect of O_3 on these relationships.

22501 (DOE/ER/60883-1) **Simulation of landscape disturbances and the effect of climatic change: Technical progress report No. 1, [July 1989-February 1990].** Baker, W.L. Kansas Univ., Lawrence, KS (USA). Dept. of Geography. 1 Mar 1990. 109p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60883. Order Number DE90007565. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This first progress report covers the seven month period from July 1989 through February 1990, during which the primary achievements have been in developing the conceptual framework for the model and in writing code. This project is the first to attempt to directly model the effects of changing atmospheric conditions, on the decadal and century scale, on landscapes whose structure is influenced by atmospherically-controlled natural disturbances. The model has a landscape ecological emphasis, meaning that the primary concern is with the patchy structure present in landscapes on the kilometers scale. A central feature of this model, in addition to the tie to atmospheric conditions, is that it contains an analytical tool, the program STRUCT, for monitoring a variety of quantitative changes in landscape structure at several scales as the model runs. 36 refs., 1 fig.

22502 (GSF-BPT-1/89) **Meteorological testing and analysis of sampling equipment for wet deposition.** Winkler, P.

(Deutscher Wetterdienst, Hamburg (Germany, F.R.). Meteorologisches Observatorium); Jobst, S.; Harder, C. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Bereich Projekttraegerschaften. 1989. 315p. (In German). Contract BMFT 07431073. Order Number DE90759067. Available from NTIS (US Sales Only), PC A14/MF A01.

11 rain collector types for wet deposition were subjected to a field test. Two of the nine types were identically constructed. The following measured values were analyzed: amount of rainfall, electrical conductivity, pH value, Cl^-, NO_3^-, $SO_4^{=}$, NH_4^+, Na^+, K^+, Ca^{++}, Mg^{++}, Fe, Pb, Cu, Cd. The analysis was restricted to rainfall. In a basic study structural and statistical analyses of precipitations were made in order to find out from which extent of intensity resp. rain volume per rainfall the precipitations are important for wet deposition. Some sensors required intensities of nearly 1 mm/h in order to recognize all rainfalls. In order to reach a better standardization of the measuring technique the funnel geometry should be standardized. The current technique is not suited for correctly registering the deposition which is connected with light and very light rainfall. It was found out in rinsing tests with diluted HNO_3 that considerable amounts of trace metals accumulate at funnel walls and in headers, although the collecting device had been subjected to a thorough acid purification before. For the determination of the wet deposition of the trace metals problems arise if the samples are filtered and the filters are not analyzed. In that case particle-bound metals which are suspended in raindrops will not be registered. After comparing the equipment some of the devices were improved in order to eliminate known sources of contamination. (orig./KW).

22503 (GU/G–EN57-27/1989-01) **Climate warming and Canada's comparative position in argiculture.** Climate change digest 89-01. Smit, B. Guelph Univ., ON (Canada). Dept. of Geography. 1989. 31p. (MICROLOG–89-05472). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A comparative analysis has been undertaken to assess the implications of climate warming for the competitive position of Canadian agriculture. Impacts of an altered climate on Canadian production and trade opportunities for selected crops are assessed relative to impacts in other regions of the world. Information on the impacts of climatic warming on agricultural production in each of the global regions was obtained by reviewing independent studies. A measure of consistency was ensured by assuming a climate change scenario based upon an enriched CO_2 atmosphere and by specifying a range of temperatures for each region. Five approaches were used for estimating the climate change impacts on agriculture: crop yield analysis, spatial shift analysis, spatial and historical analogues, agricultural systems models, and assessments based on expert judgment. Some highlights of the analyses are as follows. Production prospects for wheat and grain corn may be enhanced in Canada and the Soviet Union, and may diminish in most other regions of the world. Opportunities for producing soybeans may decrease in the world's major producing regions, particularly the USA and Central America. The production of rice in Asian countries may increase. Canada's position in production and trade of wheat and grain corn may improve relative to the rest of the world. Impacts are likely to vary among regions in Canada, with ramifications for regional development policies. 3 tabs.

22504 (JAERI-M–89-155) **Environmental radiation data, 7: Background dose rate in and around Tokyo measured with portable instruments.** Nagaoka, Toshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sakamoto, Ryuichi; Saito, Kimiaki; Tsutsumi, Masahiro; Moriuchi, Shigeru. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 35p. (In Japanese). Order Number DE90759885. Available from NTIS (US Sales Only), PC A03/MF A01.

The Environmental Radiation Physics Laboratory has conducted a large number of background radiation surveys in these years, aiming at the analysis of characteristics and behaviour of environmental radiation, the development of measurement techniques and instruments of environmental radiation, and the evaluation of environmental radiation dose. The environmental radiation data obtained by these surveys are useful for broad purposes as actual survey data. Therefore, it is desirable to make the recording media and the FORMAT of these data available for usual computers. In the light of this circumstance, these data were rearranged and recompiled systematically to meet the demand. This report mentions about the data obtained by the background radiation surveys in and around Tokyo performed during 1982 - 1988 using portable instruments, as well as the information necessary for the data handling. (author).

22505 (KFK-PEF–54) **Cost-effectiveness-analysis of strategies to reduce the SO_2- and NO_x-emissions in Baden-Wuerttemberg considering regional aspects.** Boysen, B. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme); Mattis, M.; Friedrich, R.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Sep 1989. 110p. (In German). Contract PEF 87/001/4. Order Number DE90759333. Available from NTIS (US Sales Only), PC A06/MF A01; OSIT; INIS.

Costs and effectiveness of several measures for reducing SO_2- and NO_x-emissions are evaluated. Regional aspects can be taken into account due to the calculations on county-level. At first the emissions are calculated for each of Baden-Wuerttemberg's 44 counties in the year 1985. The next step is the estimation of the emissions for the year 2000 on the base of the fuel use expected. This projection considers all measures which are necessary to meet the existing and future laws. In addition to this the costs and the effects of further abatement measures are given. From the results it is possible to get information about the costs necessary to reach a certain level of emissions. Furthermore it is known which measures have to be taken. From the results strategies and recommendations for a cost-effective air-pollution-control policy can be developed. (orig.) With 42 figs., 62 refs.

22506 (MCC–CE02780, pp. 279-284) **Perturbations in atmospheric density caused by high rise buildings and their effects on astronomical observations: A case study.** Kirts, R.E. (U.S. Naval Civil Engineering Lab., Port Hueneme, CA (USA)); Kodres, C.A. MCC Systems Canada, Inc., Toronto, ON (Canada). 1989. (CONF-890615–: Building simulation '89, Vancouver (Canada), 23-24 Jun 1989; CE–02780). In *Proceedings of building simulation '89.* Available from MCC Systems, 30 Wellington St. E, Suite 202, Toronto, ON, CAN M5E 1S3. Prices: $90.00 CAN.

Proposed construction of high rise buildings near the U.S. Naval Observatory in Washington D.C. caused astronomers to ask what effect the heat released by these buildings would have on their ability to make accurate observations. Models of the thermal performance of the proposed buildings were developed and used to estimate the rate of heat release to the atmosphere. The building heat release rates, along with other data, were input to a finite volume fluid mechanics computer program which was used to model the atmosphere near the Naval Observatory. The atmospheric model produced estimates of the gradients in air density above the Observatory. The atmospheric model produced estimates of the gradients in air density above the Observatory. From these air density data it was estimated that the proposed construction would diminish the accuracy of the Observatory's measurements by a factor of several times the currently acceptable error. 2 refs., 6 figs.

22507 (MO/G–57-27/1988-08) **The implications of climate change for natural resources in Quebec.** Climate change digest, 88-08. Singh, B. Montreal Univ., PQ (Canada). Dept. of Geography. 1988. 34p. (MICROLOG–90-01110). Available from PC National Climatological Information Services, CCAS/I, 4905 Dufferin Street, Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This report presents the summary results of a study on the implications of long-term climate change for energy, agriculture and forestry in Quebec, selected due to their economic importance. In the energy sector, the hydro-electric power generating potential of the James Bay area was examined, as well as the projected interior space heating requirements in the southern part of the province. An increase in the net basin supply of from 7%-20% for 3 drainage

basins within the James Bay area was postulated, giving a potential increase in generating capacity of about 9.3 x 10-12th W/h for the 3 basins combined. Significant decreases in heating degree-days for Montreal (25%) and Quebec City (35%) were possible. In the forestry sector, the potential for displacement of tree communities and changes in tree growth rates were examined. These changes could lead to northward displacement of major forest ecosystems, drastic decreases in tundra forest area, and a potential decrease in boreal forest area of about 20% but with better growth rate. In the agriculture sector, the projected effects on agroclimatic resource potential and on crop productivity led to a substantial increase in the length of the growing season, a sharp increase in growing degree-days in all regions (40%-105%) and increased cultivation of grapes and apples. The crops examined included grain and fodder corn, soybeans, potatoes, spring wheat, beans, sorghum, barley, oats, rape-seed sun flowers, and orchard crops such as grapes and apples. Preliminary economic impact assessments involving simple cost-benefit analyses were performed. 4 figs., 2 tabs.

22508 (N–90-13618) **Computational solution of chemistry problems. Final report, period ending 30 June 1988.** Ake, R.L. Old Dominion Univ., Norfolk, VA (USA). Nov 1989. 26p. (NASA-CR–186000;NAS–1.26:186000). Available from NTIS, PC A03/MF A01.

AB initio quantum chemical techniques have been used to investigate weakly bound complexes of H2O and SO2. An energy gradient program was used to locate stable structures for the H2O, SO2 complexes, and SCF calculations were carried out to determine the binding energies of complexes with multiple water molecules. A 4-31G basis set was used for most potential energy searches. More accurate basis sets including a generally contracted basis set with d orbitals on the sulfur were used for geometry and binding energy verification. For single water complexes, five different stable geometries were located with binding energies between 4 and 11 Kcal mol(-1), suggesting a binding shell for H2O around SO2 and a mechanism for the formation of an SO2-containing water droplet. Calculations on one of the complexes utilizing a larger double zeta basis and d functions on the sulfur atom lead to adjusted binding energies in the range 3 to 8 Kcal mol(-1). Very little charge transfer between SO2 and H2O was present. Addition of more than one H2O was found to be energetically favorable although the addition of the fourth water in certain geometries did not increase the stability of the complex. An alternative mechanism for the tropospheric gas phase production of acid rain is suggested.

22509 (ORNL/CDIAC–30) **United States Historical Climatology Network (HCN) serial temperature and precipitation data.** Boden, T.A. (ed.); Karl, T.R.; Williams, C.N. Jr.; Quinlan, F.T. Oak Ridge National Lab., TN (USA). Jan 1990. 381p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (NDP–019/R1). Order Number DE90008029. Available from NTIS, PC E17/MF E08 - OSTI; GPO Dep.

Includes 28 microfiche supplements; Environmental Sciences Division Publication No. 3404.

This document describes a data base containing monthly temperature and precipitation data for 1219 US stations. This network of stations, known as the Historical Climatology Network (HCN), and the resulting data base were compiled by the National Climatic Data Center. These data represent the best available data from the United States for analyzing long-term climate trends on a regional scale and may be used for studies attempting to determine the climatic impacts of increased concentrations of greenhouse gases. Unlike most data sets that have been used in past climate studies, these station data have been adjusted to remove biases introduced by station moves, instrument changes, time-of-observation differences, and urbanization effects. These monthly data, along with supporting data, including station inventories, station histories, temperature corrections for time-of-observation bias, and data quality assessments, are available free of charge as a numeric data package (NDP) from the Carbon Dioxide Information Analysis Center. The NDP consists of this document and magnetic tapes containing machine-readable data files, supporting data files, a descriptive file, and computer access codes. This document describes how the stations in the HCN were selected and how the data were processed, defines limitations and restrictions of the data, describes the format and contents of the magnetic tape, and provides reprints of literature that discuss the editing and adjusting techniques used for the HCN. 16 refs., 1 fig., 27 tabs.

22510 (PB–90-130105/XAB) **Investigation of the determination of respirable quartz on filter media using Fourier transform infrared spectrophotometry.** Lorberau, C. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering. 29 Sep 1989. 73p. Available from NTIS, PC A04/MF A01.

The use of Fourier transform infrared spectrophotometry for the determination of quartz in respirable dust directly on filter media was investigated. Fifteen different 25-mm filters which might be used in a respirable dust sampler were examined. With the best of these, the limit of detection in practical operating conditions (three times the standard deviation of the blank) was estimated to be 3 micrograms with linearity in excess of 1 mg. The spatial inhomogeneity of the filter background appears to be a limiting factor to the sensitivity. Procedures were devised to correct for the filter background and the absorbance of relatively non-structured interferences, such as coal dust. In addition, two methods to correct for the interference of the overlapping absorbance bands of other minerals (kaolinite, cristobalite) with those of quartz were also studied. Scaled spectral subtraction of reference spectra of the interferences provided results that did not differ significantly from those which were obtained by a more traditional approach. Both methods overcorrected for the presence of the interference. The absorbance signal per unit weight of quartz was observed to be influenced by particle size within the respirable range.

22511 (PB–90-130352/XAB) **National air quality and emissions trends report, 1987.** Curran, T.C.; Faoro, R.B.; Fitz-Simons, T.; Frank, N.H.; Hunt, W.F. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. 1987. 152p. (EPA–450/4-89/001). Available from NTIS, PC A08/MF A01.

See also report for 1986, PB–88-172473.

This report presents national and regional trends in air quality from 1978 through 1987 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and lead. Air-pollution trends were also examined for the 5-year period (1983-87). Both national and regional trends in each of these pollutants are examined. National air-quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories. In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements.

22512 (PB–90-130451/XAB) **Catching our breath: Next steps for reducing urban ozone.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Jul 1989. 249p. (OTA-O–412). Available from NTIS, PC A11/MF A02.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600715.

Contents include: summary; ozone and the Clean Air Act; health effects of ozone; effects of ozone on crops and forests; lowering ozone; effect of controlling volatile organic compounds and nitrogen oxides; controlling emissions of volatile organic compounds; new opportunities for controlling ozone; and policy options.

22513 (PB–90-130832/XAB) **Analysis of state and federal sulfur dioxide emission regulations for combustion sources (revised).** Vitas, J.B.; Pandullo, R.F.; Pickett, D. Radian Corp., Research Triangle Park, NC (USA). Sep 1989. 433p. Available from NTIS, PC A19/MF A03.

See also PB–83-179838.

State implementation plan (SIP) regulations and Federal new source performance standards (NSPS) pertaining to sulfur dioxide (SO2) emissions from fuel-combustion sources have been compiled and summarized in the report. State regulations which were submitted to the Environmental Protection Agency (EPA) and have been approved as part of the SIP as of December 31, 1988 are included. The source categories to which the regulations presented herein apply are broadly defined as indirect and direct heat exchangers, and primary steam generators (boilers). The report will

serve as a quick reference for estimating SO2 emission rates, assessing ranges of SO2 control, and quantifying the relative stringency of emission limits. Users are cautioned, however, to contact the appropriate State and/or local air pollution control agency and EPA Regional Office to verify the specific SO2 emission limit that is applicable to an individual source.

22514 (PB–90-131335/XAB) **Walk-through survey report, control technology support for sensor at Ingersoll-Rand Company, Foundry Division, Phillipsburg, New Jersey, March 2, 1989.** O'Brien, D.; Froehlich, P.; Hall, R. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1989. 25p. (CT–171-17A). Available from NTIS, PC A03/MF A01.

A walk-through study was made of the Ingersoll-Rand Company, Phillipsburg, New Jersey to evaluate the facility for an in depth study in which potential worker exposures to silica containing dusts would be measured and a study made of work practices and administration control programs being used to reduce these dust exposures. The firm has operated both gray iron and steel foundries at the site, but at this point the gray iron foundry had closed. The facility was a captive foundry producing steel and stainless steel castings for the parent company. Five induction furnaces were used to melt the scrap. The foundry produced molds using an alkyd/oil molding system. Casting appendages were removed by either an air or oxygen torch in one of two ventilated booths. Grinding of bronze castings was performed in an adjacent booth. This report recommends the modification of the semi-automatic system to allow all molds to be isolated once they are poured, and substitute of olivine sand for silica to reduce the incidence of silicosis. A potential exposure of hand grinding operators will be lessened if the castings are as clean as possible before grinding. Improvements in the local exhaust ventilation system and in the general ventilation system are also recommended.

22515 (PB–90-131343/XAB) **Walk-through survey report, control technology support for sensor at General Foundry Company, Flagtown, New Jersey, March 1, 1989.** O'Brien, D.M.; Froehlich, P.A.; Hall, R.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 26p. (CT–171-16A). Available from NTIS, PC A03/MF A01.

A walk-through survey was conducted at the General Foundry Company, Flagtown, New Jersey to evaluate control methods used to reduce worker risk of silicosis and assist in developing similar programs for other similar factories. The facility employed 20-22 hourly and eight salaried persons, one shift, 6 days a week. The facility was a job shop producing ferrous castings. Purchased scrap and graphite were stored inside the foundry adjacent to the furnace area. Two induction furnaces melted the scrap. Molds were produced in both green sand and furan no-bake molding systems. After shakeout and cooling, castings were cleaned by steel shot in either a swing table or tumble blast abrasive cleaning cabinet. Potential hazards included exposure to crystalline silica, metals, decomposition products, carbon monoxide, alcohols, formaldehyde, hydrogen cyanide, phenol and sulfur compounds. Engineering control methods included the substitution of front-end loader sand handling with a large foundry grade vacuum system exhausting through appropriate filters to the outdoors. The use of ventilation to effect control was virtually impossible. For silica, olivine could be substituted in this foundry and this would reduce the incidence of silicosis. Improving local-exhaust ventilation and general ventilation and using good work practices are recommended.

22516 (PB–90-131350/XAB) **Walk-through survey report, control technology support for sensor at Alloy-Tech, Inc., Delran, New Jersey, February 27, 1989.** O'Brien, D.; Froehlich, P.; Hall, R. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1989. 23p. (ECTB–171-15A). Available from NTIS, PC A03/MF A01.

A walk through study was made of Alloy-Tech, Inc., Delran, New Jersey for the purpose of evaluating this facility for an in-depth study in which potential worker exposures to silica containing dusts would be measured and a study made of work practices and administration control programs being used to reduce these dust exposures. This facility produced ferrous castings to order in alloys ranging from iron to stainless steel. Scrap was melted in induction furnaces. Green sand molds and no bake molds were both used at the site. Castings were cleaned by steel shot in an abrasive blasting cabinet. Personal protective equipment included safety shoes, safety glasses, hard hats and ear plugs. The highest silica exposures in the facility occurred during the handling of the molding sands and during cleaning of the castings. The report recommends the substitution of broom and shovel sand handling with large foundry grade vacuum systems to lower exposures and increase productivity. The substitution of olivine for foundry sand is also suggested. Shakeout, sand screening and sand mulling operations will also benefit from the substitution of olivine. Some modifications in equipment are suggested along with upgrading in the ventilation systems.

22517 (PB–90-131376/XAB) **Heart-disease mortality among bridge and tunnel officers exposed to carbon monoxide.** Stern, F.B.; Halperin, W.E.; Hornung, R.W.; Ringenburg, V.L.; McCammon, C.S. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. 1989. 38p. Available from NTIS, PC A03/MF A01.

A retrospective study was conducted of 5529 New York City bridge and tunnel officers to determine the effect of occupational exposure to carbon monoxide (CO) with specific reference to heart disease mortality. Continuous monitoring of CO within the tunnels operated by the Triborough Bridge and Tunnel Authority began in 1940. In 1961 the 24 hour average CO concentrations inside the tunnels were 53 parts per million (ppm) in the summer and 49ppm in the winter with peaks of 200 to 300ppm in the summer and 100 to 200ppm in the winter. Monitoring in 1970 indicated CO levels of 63ppm in tunnel toll booths and 13ppm in bridge toll booths. In 1977 ventilation equipment which had been installed was linked to continuously reading CO monitors. Peak 1981 CO exposures in the traffic lanes of both the tunnel and bridge and on the tunnel catwalk were often greater than 100ppm and sometimes surpassed 400ppm. Arteriosclerotic heart disease (ASHD) was the cause of death in 61 former tunnel officers as compared to the expected number of 45. A Cox proportional hazards model was used to compare the risk of mortality from ASHD among tunnel officers to the less exposed bridge officers. While there was a significant association between exposure and age, no association of ASHD was noted with length of exposure.

22518 (PB–90-131434/XAB) **Alternative control technology document: Ethylene oxide sterilization/fumigation operations.** Midwest Research Inst., Cary, NC (USA). Mar 1989. 100p. Available from NTIS, PC A05/MF A01.

This report presents technical information that State and local agencies can use to develop strategies for reducing VOC (i.e., EO) emissions for sterilization/fumigation facilities. The information in the document will allow planners to identify available control alternatives and evaluate the VOC reduction and cost of implementing controls. The document provides information on sterilization/fumigation processes, EO (ethylene oxide) emissions, and emission reductions, and cost associated with the application of control units. Section 2.0 presents a summary of the findings of the study. Section 3.0 provides a description of sterilization/fumigation facility operations and emission sources. Section 4.0 provides a description of alternative control techniques for the reduction of ethylene oxide emissions. Section 5.0 presents a cost analysis that includes a methodology for computing annualized equipment and operating costs. A list of contacts at various Federal agencies who are knowledgeable about sterilization/fumigation processes is presented in Appendix A.

22519 (PB–90-131442/XAB) **Evaluation of emission-control devices at waterboard plants. Final report.** Vaught, C.C. Midwest Research Inst., Cary, NC (USA). Oct 1989. 101p. Available from NTIS, PC A06/MF A01.

The document discusses emissions from wood-chip dryers and the candidate control devices that should be considered in a best available control technology analysis. Specifically, the document characterizes wood-chip dryer effluents and presents a general description, pollutant removal efficiencies, factors affecting performance, and cost for the wet electrostatic precipitator and the electrified filter bed. The document also presents information on controlling formaldehyde emissions from the press vents.

22520 (PB–90-131459/XAB) **NATICH (National Air Toxics Information Clearinghouse) data base report on state, local, and EPA (Environmental Protection Agency) air toxics activities. Interim report.** Radian Corp., Austin, TX (USA). Jul 1989. 745p. Available from NTIS, PC A99/MF A04.

This report disseminates information provided to the NATICH data base by State and local air agencies and EPA on their air-toxics activities. It both updates and extends (in new tables) the information in the first six reports. The report includes a listing of State and local agencies that have provided information to the clearinghouse, air-toxics contacts, regulatory program information, acceptable ambient concentration guidelines or standards and the bases of those guidelines/standards, pollutant research information, methods development activities, permitting data, source testing data, ambient monitoring information, emissions inventory information, and selected EPA risk-assessment information. Because of the large volume of data that now resides in the data base, the document reports only a subset of permitting and source data.

22521 (PB–90-131491/XAB) **Environmental Radiation Data: Report 53, January-March 1988. Quarterly report.** Environmental Protection Agency, Montgomery, AL (USA). Eastern Environmental Radiation Facility. Sep 1988. 45p. (EPA–520/5-88/057). Available from NTIS, PC A03/MF A01.

See also PB–89-135958.

Environmental Radiation Data (ERD) contains data from the Environmental Radiation Ambients Monitoring System (ERAMS). Data from similar networks operated by contributing States, Canada, Mexico, and the Pan American Health Organization are reported in the ERD when available. The ERAMS is comprised of nationwide sampling stations that provide air, surface, and drinking water and milk samples from which environmental radiation levels are derived. Sampling locations are selected to provide optimal population coverage while functioning to monitor fallout from nuclear devices and other forms of radioactive contamination of the environment.

22522 (PB–90-131509/XAB) **Environmental Radiation Data: Report 54, April-June 1988. Quarterly report.** Environmental Protection Agency, Montgomery, AL (USA). Eastern Environmental Radiation Facility. Dec 1988. 49p. (EPA–520/5-88/058). Available from NTIS, PC A03/MF A01.

See also PB–90-131491.

Environmental Radiation Data (ERD) contains data from the Environmental Radiation Ambients Monitoring System (ERAMS). Data from similar networks operated by contributing States, Canada, Mexico, and the Pan American Health Organization are reported in the ERD when available. The ERAMS is comprised of nationwide sampling stations that provide air, surface and drinking water and milk samples from which environmental radiation levels are derived. Sampling locations are selected to provide optimal population coverage while functioning to monitor fallout from nuclear devices and other forms of radioactive contamination of the environment.

22523 (PB–90-131863/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on cotton dust before the House Committee on Education and Labor, Subcommittee on Labor Standards, by James A. Merchant, May 16, 1979.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 16 May 1979. 12p. Available from NTIS, PC A03/MF A01.

The testimony summarized information available on respiratory disease arising from exposure to cotton dust which will appear in a comprehensive study the National Institute for Occupational Safety and Health (NIOSH) has undertaken together with the Department of Labor at the request of Congress. The NIOSH portion of the study involved a detailed description of methods of epidemiological and environmental investigation of occupational respiratory disease, assessment of impairment and disability and a series of chapters on specific categories of occupationally induced respiratory disease. In this testimony, specific information was imparted regarding byssinosis. Topics included: byssinosis; the number of exposed workers; etiological agents; Monday morning chest tightness; chronic effects; epidemiology; disability; and cigarette smoking as a risk factor. Elements important to standards for compensation for disability from cotton-dust exposure were suggested.

22524 (PB–90-132341/XAB) **NAPAP (National Acid Precipitation Assessment Program) emissions inventory (version 2): Development of the national utility reference file, 1985. Final report, January-September 1989.** Wagner, J.K.; Rothschild, S.S.; Istvan, D.A. Pechan (E.H.) and Associates, Inc., Springfield, VA (USA). Nov 1989. 193p. Available from NTIS, PC A09/MF A02.

For system on magnetic tape, see PB–90-500992. For system on diskette, see PB–90-501008.

The report gives results of a project conducted to create a file containing comprehensive data on all electric utilities in the US. The National Acid Precipitation Assessment Program's (NAPAP's) emissions inventory activities focus on the estimation of emissions from pollutants that contribute to acid deposition. Electric utilities, which emit a large share of total acid deposition precursor emissions, are important for modeling analyses. Data reported by states to the National Emissions Data System (NEDS) for the 1985 NAPAP Emissions Inventory and data reported to the U.S. Department of Energy (DOE) on EIA Form 759, EIA Form 767, FERC Form 423, and the Integrated Data Base System (IDBS) were matched and combined. The resulting 1985 National Utility Reference File (NURF) contains detailed unit level data for nearly 10,000 electricity generating plants.

22525 (PB–90-132663/XAB) **Distribution and variability of precipitation chemistry in the conterminous United States, January through December 1983. Open file report.** Rinella, J.F.; Miller, T.L. Geological Survey, Portland, OR (USA). Water Resources Div. 1988. 251p. (USGS/OFR–87-558). Available from NTIS, PC A12/MF A02.

Analyses of atmospheric precipitation samples, collected during the 1983 calendar year from 109 National Trends Network sites in the United States, are presented. The sites were grouped into six geographical regions based on the chemical composition of the samples. Precipitation chemistry in these regions was influenced by proximity to (1) oceans, (2) major industrial and fossil-fuel consuming areas, and (3) major agricultural and livestock areas. Frequency distributions of ionic composition, determined on 10 chemical constituents and on precipitation quantities for each site, showed wide variations in chemical concentrations and precipitation quantities from site to site. Of the 109 sites, 55 had data coverage for the year sufficient to characterize precipitation-quality patterns on a nationwide basis.

22526 (PB–90-132689/XAB) **Radon fundamentals and the effectiveness of coatings in reducing soil gas flow through block basement walls. Report for May 1988-March 1989.** Ruppersberger, J.S. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1989. 10p. (EPA–600/D-89/205). Available from NTIS, PC A02/MF A01.

This paper gives results of an evaluation of six different coatings in specially designed chambers built around 1.5 sq m concrete-block-wall sections. Data were collected over a pressure range of 1-12 Pa with flows from < 0.01 to 50 standard liters/minute (SLPM). The six coatings were a water-based catalyzed epoxy paint, an elastomeric paint, a cementaceous block filler, a surface bonding cement, a polysulfide vinyl acrylic paint, and a latex paint. A major preliminary finding is that all six coatings proved to be highly effective (98-plus %) when enough material is carefully applied. This large variation in a small sampling of blocks is significant not only in the potential impact on coating performance but also, more significantly, that specification of blocks with low air permeability for new construction substructures could greatly reduce soil gas entry, even if left uncoated.

22527 (PB–90-132705/XAB) **Gypsum-wallboard formaldehyde-sorption model.** Silberstein, S. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Building Technology. Nov 1989. 22p. (NISTIR–89/4028). Available from NTIS, PC A03/MF A01.

Gypsum wallboard was shown to absorb formaldehyde in a prototype house and in a measuring chamber, as reported previously by researchers at Oak Ridge National Laboratory (ORNL). Also as reported previously, formaldehyde concentrations attained equilibrium in two phases in response to a change in the air exchange rate or to the removal of the formaldehyde source. A rapid initial

phase was followed by a slow phase lasting several days. A formaldehyde sorption model that accounts for the biphasic concentration pattern is presented here. Experiments for testing the predictability of the model are proposed.

22528 (PB–90-132903/XAB) **Structural changes during the decomposition of calcium hydroxide. Report for October 1988-July 1989.** Jozewicz, W.; Kirchgessner, D.A.; Gullett, B.K. Acurex Corp., Research Triangle Park, NC (USA). Environmental Systems Div. c 1989. 18p. Available from NTIS, PC A03/MF A01.

The paper discusses the production of calcium hydroxides with surface areas of 6-74 sq m/g, in an attempt to develop more reactive sorbents for SO_2 capture during furnace injection. It was found that adding alcohol to the water of hydration yielded hydroxides with surface areas up to 40 sq m/g. The sorbents were produced using double hydration and a mixture of water and methyl alcohol. When these sorbents were injected into the boiler, however, only marginal increases in SO2 capture were observed. The purpose of the research was to monitor structural changes in these sorbents during calcination in order to determine the reason for their relatively poor performance. For a given calcine and fixed conditions of calcination, the surface area decreased and median pore size increased with decreasing particle size in the 1.2-7.5 micrometer size range. This suggests that sintering advances more quickly in fine particles. For sorbents described here and using one precursor limestone, a correlation could be found between structural properties of Ca(OH)2 and nascent CaO. Increased surface area of Ca(OH)2 led to higher surface area of CaO after calcination at fixed conditions. The theoretical existence of an optimum combination of surface area and porosity of CaO was verified.

22529 (PB–90-139965/XAB) **Health assessment for Juncos Landfill, Juncos, Puerto Rico, Region 2. CERCLIS No. PRD980512362. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 23 Apr 1984. 11p. Available from NTIS, PC A03/MF A01.

The Juncos Landfill near Juncos, Puerto Rico was operated for 20 years until 1977. In 1982, preliminary investigation by EPA Region II revealed that the most extensive contaminant was elemental mercury, spilled from and contained within large numbers of broken thermometers dumped at the landfill. Ambient air monitoring performed February 10, 1983 by the Region II Field Investigation Team showed that several organic solvents were present in the air, both on- and off-site, in addition to the mercury. As a result of these studies, the landfill was placed on the National Priority List. Subsurface sampling of the dumpsite to determine if other pollutants are present has not been performed. The known pollutant of concern at the landfill is mercury. In the present situation, this metal can create health risks in the forms of mercury vapor (elemental) and methylmercury (organic).

22530 (PB–90-500968/XAB) **Development of the National Acid Precipitation Assessment Program (NAPAP) Anthropogenic Emissions Inventory, 1985: Annual point sources, Version 1. Data file.** Mobley, J.D.; Saeger, M. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. mag ta Available from NTISCP T03.

See also PB–88-137138, PB–88-137302, and PB–88-137179. Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–88-132121.

This file contains Annual Emissions and Facility Data for point sources of air pollutants included in the 1985 NAPAP Emissions Inventory Version 1. The inventory spans the 48 contiguous U.S. states and 10 Canadian provinces, providing detailed point-source data for over 14,000 plants and area-source information by source category for 3,070 U.S. counties. Canadian area source data are reported at the province level. Summaries of emissions data are presented at various levels of aggregation including nation, EPA region, state/province, and source category. Emissions data are also analyzed by plant size, stack height, and general source type, and emissions variations are examined on seasonal and daily bases.

22531 (PB–90-500976/XAB) **Development of the National Acid Precipitation Assessment Program (NAPAP) Anthropogenic Emissions Inventory, 1985: Annual area source county level fuel use and activity levels, Version 1. Data file.** Mobley, J.D.; Saeger, M. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. mag ta Available from NTISCP T02.

See also PB–88-137138, PB–88-137302, and PB–88-137179. Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–88-132121.

The file contains county level activity and allocation data used to develop the 1985 NAPAP Area Source Emissions Inventory Version 1. The inventory spans the 48 contiguous U.S. states and 10 Canadian provinces, providing detailed point source data for over 14,000 plants and area source information by source category for 3,070 U.S. counties. Canadian area source data are reported at the province level. Summaries of emissions data are presented at various levels of aggregation including nation, EPA region, state/province, and source category. Emissions data are also analyzed by plant size, stack height, and general source type, and emissions variations are examined on seasonal and daily bases.

22532 (PB–90-500984/XAB) **Development of the National Acid Precipitation Assessment Program (NAPAP) Anthropogenic Emission Inventory, 1985: Annual area source emissions, Version 1. Data file.** Mobley, J.D.; Saeger, M. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. mag ta Available from NTISCP T02.

See also PB–88-137138, PB–88-137302, and PB–88-137179. Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–88-132121.

The file contains annual emissions data at the county level for area source categories included in the 1985 NAPAP Emissions Inventory Version 1. The inventory spans the 48 contiguous U.S. states and 10 Canadian provinces, providing detailed point-source data for over 14,000 plants and area source information by source category for 3,070 U.S. counties. Canadian area source data are reported at the province level. Summaries of emissions data are presented at various levels of agtregation including nation, EPA region, state/province, and source category. Emissions data are also analyzed by plant size, stack height, and general source type, and emissions variations are examined on seasonal and daily bases.

22533 (PB–90-500992/XAB) **Development of the National Acid Precipitation Assessment Program (NAPAP) National Utility Reference File (NURF) emissions inventory, 1985, Version 2. Data file.** Wagner, J.K.; Rothschild, S.S. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. mag ta Available from NTISCP T02.

See also PB–88-137153 and PB–88-137138. Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–90-132341.

The EBCDIC file contains unit-level data for every existing and planned electric generating unit in the U.S. The data represent the year 1985. The data were obtained from EPA and DOE data bases and merged into a single comprehensive data base for all electric utilities. Categories of data included are identification and location information; unit operation characteristics (e.g., prime mover, capacity, bottom type, firing type); unit lifetime data; fuel consumption and quality data; regulatory information; emissions and pollution control data; and ownership information. A preamble to the file provides file layout information.

22534 (PB–90-855230/XAB) **Indoor radon pollution: Control and mitigation. June 1978-December 1989 (Citations from the NTIS data base). Report for June 1978-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 79p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the control and mitigation of radon pollution in homes and commercial buildings. Citations cover radon transport studies in buildings and soils, remedial action proposals on contaminated buildings, soil venting, building ventilation, sealants, filtration systems, water degassing, reduction of radon sources in building materials, and evaluation of existing radon mitigation programs including their cost effectiveness. Analysis and detection of radon and radon toxicity are covered in separate published bibliographies. (Contains 129 citations fully indexed and including a title list.)

22535 (PB–90-856865/XAB) **Remote sensing applied to environmental-pollution detection and management. July 1987-January 1990 (Citations from the NTIS data base). Report for July 1987-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 57p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855399.

This bibliography contains citations concerning the utilization of remote sensing techniques and equipment to study air- and water-pollution problems. Topics include the use of aerial photographs, various radar techniques, and spaceborne photography to study oil spills, ocean-dumping sites, plume dispersions, and pollution problems in estuaries. Data interpretation and processing techniques are also discussed. (This updated bibliography contains 84 citations, 30 of which are new entries to the previous edition.)

22536 (PB–90-857012/XAB) **Air-pollution sampling of particles. February 1981-April 1986 (Citations from the NTIS data base). Report for February 1981-April 1986.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 101p. Available from NTISPC N01/MF N01.

See also PB–90-857020.

This bibliography contains citations concerning the techniques of sampling particles in the earth's atmosphere. Sampling procedures, sampler design and performance, site selection, sampling networks, and meteorological effects are discussed. (This updated bibliography contains 199 citations, none of which are new entries to the previous edition.)

22537 (PB–90-857020/XAB) **Air-pollution sampling of particles. May 1986-January 1990 (Citations from the NTIS data base). Report for May 1986-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 93p. Available from NTISPC N01/MF N01.

Supersedes PB–86-867496. See also PB–90-857012.

This bibliography contains citations concerning the techniques of sampling particles in the Earth's atmosphere. Sampling procedures, sampler design and performance, site selection, sampling networks, and meteorological effects are discussed. (This updated bibliography contains 158 citations, all of which are new entries to the previous edition.)

22538 (PNL-SA–17905) **Global warming: A Northwest perspective: Proceedings.** Scott, M.J.; Counts, C.A. (eds.). Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 103p. Sponsored by U.S. DOE Energy Research; Northwest Power Planning Council; Oregon Department of Energy; Washington State Energy Office. DOE Contract AC06-76RL01830. (CONF-8902158–1: Conference on global warming: a Northwest perspective, Olympia, WA (USA), 9 Feb 1989). Order Number DE90008140. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Northwest Power Planning Council convened a symposium in Olympia, Washington, on the subject of global climate change ("the greenhouse effect") and its potential for affecting the Pacific Northwest. The symposium was organized in response to a need by the Power Council to understand global climate change and its potential impacts on resource planning and fish and wildlife planning for the region, as well as a need to understand national policy developing toward climate change and the Pacific Northwest's role in it. 40 figs., 15 tabs.

22539 (SAND–90-8206) **1988 Annual site environmental report, Sandia National Laboratories, Livermore, California.** Siegfriedt, K.F. Sandia National Labs., Livermore, CA (USA). May 1989. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE90008006. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories at Livermore, California, is located 65 km (50 miles) southeast of San Francisco midway between the Pacific Ocean and the San Joaquin Valley. Sandia conducts various research activities related to Department of Energy interests which have the potential for release of hazardous materials or radionuclides to the environment. A strict environmental control program places maximum emphasis on limiting releases. The environmental monitoring program conducted by Lawrence Livermore National Laboratory and augmented by Sandia is designed to measure the performance of the environmental controls. The program includes analysis of air, water, soil, vegetation, sewer effluent, ground water, and foodstuffs for various toxic, hazardous, or radioactive materials. Based on these studies, the releases of materials of concern at Sandia during 1988 were well below applicable Department of Energy standards and in compliance with state and federal laws and regulations. 11 refs., 2 figs., 12 tabs.

22540 (UCRL–21295) **Status of surface processes in the LLNL zonally symmetric model.** Gleckler, P.J. (California Univ., Davis, CA (USA)). Lawrence Livermore National Lab., CA (USA); California Univ., Davis, CA (USA). 30 Sep 1989. 41p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90007284. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A surface package has been developed for use in the LLNL zonally symmetric model (ZSM). Surface energy balances are computed for both land and ocean. The ocean is modeled as a well-mixed slab, the land as a single layer with constant thermal conductivity. A land surface moisture budget includes rain, evaporation, sublimation, snowfall, snowmelt and runoff. There is a highly simplified parameterization of surface albedo for freezing oceans and snow covered land. Land and sea air is 'instantly mixed' by averaging pertinent land and sea surface variables (weighted by their respective areas in each zone) before use in subsequent atmospheric computations. Initial tests have demonstrated that the surface package is working properly. It has been demonstrated that the model produces a reasonable 'annually averaged' climate. There are some aspects of ZSM which need to be improved, most notably that of cloud cover. The next stage in the development is to test the model in seasonal mode. An improved treatment of surface albedo is currently being coded. When ZSM has been tested in seasonal mode, a sea ice routine will be added to the surface package. There are also plans to implement a method which accounts for the interaction between land and sea air. 5 refs., 15 figs.

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Refer also to citation(s) 21331, 21473, 21476, 21516, 21517, 21519, 21523, 21536, 21538, 21541, 21542, 21543, 21544, 21545, 21546, 21662, 21901, 22188, 22493, 22521, 22522, 22529, 22539, 22588, 22603, 22617, 22619, 22620, 22621, 22622, 22623, 22624, 22625, 22628, 22629, 22630, 22631, 22632, 22633, 22635, 22636, 22637, 22638, 22639, 22640, 22641, 22642, 22644, 22645, 22646, 22647, 22648, 22649, 22650, 22652, 22653, 22656, 22665, 22666, 22667, 22668, 22669, 22671, 22672, 22673, 22674, 22676, 22688, 22689, 22690, 22691, 22692, 22694, 22695, 22697, 22700, 22706, 22767, 23247

22541 (BMU–1989-212) **Studies on the realism of radioecological models.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Nov 1988. 16p. (In German). Contract BMU St.Sch. 1004. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

The basis for the tests was provided by the experimental data published on the air transport of radioactive iodine and by the measurement data on the concentration of I-131 in the air, in pastoral vegetation and in milk from April 26 to the end of June 1986, as a

consequence of the Chernobyl reactor accident for the Federal Republic of Germany. The transition from air to pastoral vegetation, from pastoral vegetation to milk and from air to milk was calculated. Besides the direct determination of these values from the measurement results, the transition factors were also derived from the data for the individual parameters fall-out rate, vegetation density, vegetation half-life, the transfer factor fodder/milk, and fodder quantity for cows. The data used for the analyses include results of investigations conducted after nuclear weapons tests and following emissions of radioactive iodine from nuclear power stations and reprocessing plants, as well as the data obtained in the framework of the program for Controlled Environmental Radioiodine Tests (CERT program). (orig./HP).

22542 (BR–85(7.26)) **The ecology of hydric hammocks: A community profile.** Vince, S.W.; Humphrey, S.R.; Simons, R.W. Fish and Wildlife Service, Washington, DC (USA); Florida Museum of Natural History, Gainesville, FL (USA). Sep 1989. 82p. Sponsored by U.S. Department of the Interior. Available from NTIS, PC A05/MF A01; OSTI - US Fish and Wildlife Service, 18th and C Streets, N.W., Mail Stop 1111, Arlington Square Building, Washington, DC 20240.

This publication describes the nature and dynamics of a type of forested wetland called hydric hammock. Hydric hammock has not been carefully defined or studied, and it often is ignored or lumped with other mixed hardwood forests. Hydric hammock occurs at low elevations along the gulf coast of Florida from Aripeka to St. Marks and at various inland sites in Florida. The largest contiguous tracts occur along the gulf coast and the St. Johns River. Sites typically are gentle slopes between mesic hammock or pine flatwoods and river swamp, wet prairie, or marsh. Hydric hammocks occur on soils that are poorly drained or have high water tables, and occasional flooding saturates the soils long enough to restrict or modify species composition. Hydric hammocks typically contain live and swamp laurel oaks (*Quercus virginiana* and *Quercus laurifolia*), cabbage palm (*Sabal palmetto*), southern red-cedar (*Juniperus silicicola*), sweetgum (*Liquidambar styraciflua*), and hornbeam (*Carpinus caroliniana*). Hydric hammocks lack certain tree species while sharing others with both upslope mesic forests and downslope swamp forests. The vertebrate fauna contains no unique species but has a high diversity of species and high abundance of selected species. Hydric hammocks are particularly important habitat for game species and for overwintering passerine birds. 148 refs., 40 figs., 12 tabs.

22543 (DOE/ID–22085) **Selected quality assurance data for water samples collected by the US Geological Survey, Idaho National Engineering Laboratory, Idaho, 1980 to 1988.** Wegner, S.J. Geological Survey, Idaho Falls, ID (USA). Oct 1989. 91p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (USGS/WRIR–89-4168). Order Number DE90006967. Available from NTIS, PC A05/MF A01; OSTI; INIS; USGS-OFR, U.S.G.S. Open File Service, Box 25425-Denver Federal Center, Denver, CO 80225; GPO Dep.

Multiple water samples from 115 wells and 3 surface-water sites were collected between 1980 and 1988 for the ongoing quality assurance program at the Idaho National Engineering Laboratory. The reported results from the six laboratories involved were analyzed for agreement using descriptive statistics. The analytical constituents and properties included: tritium, plutonium-238, plutonium-239, -240 (undivided), strontium-90, americium-241, cesium-137, total dissolved chromium, selected dissolved trace metals, sodium, chloride, nitrate, selected purgeable organic compounds, and specific conductance. Agreement could not be calculated for trace metals, some nitrates, purgeable organic compounds, and blank-sample analyses because analytical uncertainties were not consistently reported. However, differences between results for most of these data were calculated. The blank samples were not analyzed for difference. The laboratory results analyzed using descriptive statistics showed a median agreement of 95 percent between all useable data pairs. 13 refs., 4 figs., 24 tabs.

22544 (DOE/NP–0003) **Implementation plan for the new production reactor capacity environmental impact statement.** USDOE Office of Environment, Washington, DC (USA). Office of New Production Reactors. Dec 1989. 62p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90007646. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) proposed to site, construct, and operate new production reactor (NPR) capacity intended primarily to produce tritium and secondarily to produce plutonium for the US nuclear weapons program. DOE studies show that this new capacity is needed to ensure reliable maintenance of the nation's nuclear weapons stockpile. It also is essential that these necessary nuclear materials be produced in a safe and environmentally sound manner. The DOE has determined that this proposed action constitutes a major federal action that may significantly affect the quality of the human environment; therefore, the DOE will prepare an environmental impact statement (EIS) to assess the potential impacts of the proposed action and reasonable alternatives on the human and natural environment. The EIS will be prepared in accordance with the National Environmental Policy Act of 1969, as implemented in regulations promulgated by the Council on Environmental Quality (CEQ). This EIS implementation plan (IP) includes a description of the proposed action, descriptions of alternatives, a summary of EIS assumptions, a list of environmental issues to be considered in the EIS (including those identified during public scoping activities), a list of proposed agency consultations, a schedule for EIS preparation and related activities, and an annotated outline for the EIS. It is the Department's intent that the EIS on the NPR capacity will serve as the programmatic National Environmental Policy Act (NEPA) review of modernization of DOE defense nuclear materials production of tritium and plutonium. The Department is currently developing a NEPA compliance strategy for modernization of the remainder of the nuclear weapons production complex, which will reference the EIS on NPR capacity. 7 refs., 8 tabs.

22545 (JAERI-M–89-144) **Migration behavior of radionuclide in soil layer of final storage site: Radionuclide migration test in aerated soil layer by radioactive contaminated water.** Yamamoto, Tadatoshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Takebe, Shinichi; Ogawa, Hiromichi; Tanaka, Tadao; Mukai, Masayuki; Komiya, Tomokazu; Yokomoto, Seiichi; Wadachi, Yoshiki. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 28p. (In Japanese). Order Number DE90759881. Available from NTIS (US Sales Only), PC A03/MF A01.

Radionuclide migration tests by radioactive contaminated water were carried out using four kinds of undisturbed aerated soil samples (upper and lower layer of loamy soil, sandy soil, tuff soil) taken out from the final storage site of low-level radioactive waste, in order to obtain realistic data on radionuclide migration in the soil layer. Based on the analysis of data obtained from the tests, the retardation ability of these soil layers was evaluated. The concentration of ^{85}Sr and ^{137}Cs in effluent was less than detection limit (2×10^{-7} μCi/ml), and that of ^{60}Co rose to 5×10^{-6} μCi/ml. It was found that these soil layers have a larger retention ability of radionuclides. Difference in the radionuclide migration was observed between portions of high concentration (10^{-2} μCi/g) and low concentration (10^{-4} μCi/g) of radionuclides in the soil layer. In the portion of high concentration, a large portion of the radionuclide was adsorbed mainly on the surface of soil layers and its behavior was not dependent on kinds of soil layer. In the portion of low concentration, a slight portion of the radionuclide migrated to deeper layer. The migration rate of ^{60}Co was particularly high in the upper layer of loamy soil. Difference in the radionuclide distribution might be caused by the chemical form of radionuclide and the properties of soil layer. Calculating the retardation factor from the portion of high concentration by using the radionuclide migration model of the unsaturated soil layer, value of $10^3 \approx 10^4$ order was obtained. It was confirmed that these soil layers have a large retention ability for ionic radionuclides. As to the portion of low concentration, nonionic radionuclide are considered to be taken part in the migration and the retardation factor was $1 \approx 2$ order lower than that of the portion of high concentration. (author).

22546 (JAERI-M–89-189) **Migration behavior of radionuclide in soil layer of final storage site: Radionuclide migration test in aerated soil layer by precipitation.** Yamamoto, Tadatoshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai

Research Establishment); Takebe, Shinichi; Ogawa, Hiromichi; Tanaka, Tadao; Mukai, Masayuki; Komiya, Tomokazu; Yokomoto, Seiichi; Wadachi, Yoshiki. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 23p. (In Japanese). Order Number DE90759904. Available from NTIS (US Sales Only), PC A03/MF A01.

Radionuclide migration tests by precipitation were carried out using four kinds of undisturbed aerated soil samples (upper and lower layer of loamy soil, sandy soil, tuff soil) taken out from the final storage site of low-level radioactive waste, in order to obtain realistic data on radionuclide migration in the soil layer. Based on the analysis of data obtained from the tests, the retardation ability of these soil layers was evaluated. The concentration of ^{85}Sr and ^{137}Cs in effluent was less than detection limit ($2x10^{-7}$ μCi/ml), and that of ^{60}Co was $10^{-7} \approx 10^{-6}$ μCi/ml. In the surface soil layer, radionuclide concentration decreased exponentially with depth. A large portion of ionic radionuclide was adsorbed on the surface of soil layer and its behavior was not dependent on kinds of soil layer. In the deeper soil layer, radionuclide concentration decreased smoothly with depth. A difference in the migration of non-ionic radionuclides was observed and caused by the kinds of radionuclide and soil layer. Calculating the retardation factor from the portion of high concentration in the surface soil layer, value of $10^3 \approx 10^4$ was obtained. It was confirmed that these soil layers have a large retention ability for ionic radionuclides. As to the portion of low concentration, non-ionic radionuclides are considered to be taken part in the migration and the retardation factor was $1 \approx 2$ order lower than that of the portion of high concentration. Compared with the result of radionuclide migration test by flow down of radioactive contaminated water, some differences in retardation factor were obtained from concentration distribution of surface soil layer in this test. A slight larger retardation factor of ^{60}Co for the upper layer of loamy soil was observed in the deeper soil layer. (author).

22547 (Juel-Spez–503 B196-B218) **Residue analyses of environmental pollutants in compartments of terrestrial ecosystems.** Mueller-Wegener, U. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung Biologie, Oekologie, Energie (PBE). Jun 1989. (In German). Contract BMFT 0373673. In *Search for indicatory criteria to predict effects of chemical induced stress on ecosystemal level. Vol. 12. Final reports of sponsored projects. Pt. 2.* Order Number DE90759497. Available from NTIS (US Sales Only), PC A24/MF A01.

Methods for extraction and detection for soil, plant and animal samples of two chemicals relevant to the environment, 2,4-dichlorophenoxyacetic acid (2,4-D) and pentachlorophenol (PCP) have been evolved and optimized. The quantitative determination has been done by gas chromatography with packed columns and a detector specific to electronegative atoms, the electron capture detector (ECD). Both chemicals have been chromatographed as derivatives. The elaborated methods have been used for mass examinations of samples prepared by the zoological and botany teams (FKZ 03 73 259). (orig.).

22548 (NSS/R–160) **Small angle neutron scattering studies of diffusion and permeation through pores in clays.** Allen, A.J. (UKAEA Harwell Lab. (UK). Materials Physics and Metallurgy Div.); Baston, A.H.; Bourke, P.J.; Jefferies, N.L. United Kingdom Nirex Ltd., Harwell (UK). Sep 1988. 68p. (AERE-R–13261). Order Number DE90619464. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

An extensive study using small angle neutron scattering (SANS) has been made of the pore structures in naturally compacted London, Oxford and Lower Lias clays and in commercially purified montmorillonite and kaolinite. All the pore volumes were initially filled with H_2O. Using SANS contrast variation techniques, the accessibilities of the pores to D_2O by diffusion and permeation have been studied and the generic behaviour of each of the materials has been determined. The results are in qualitative agreement with other mass transfer measurements and suggest that access to some of the porosity takes more than a thousand hours. Most noticably in Oxford clay, a disproportionately large fraction of the surface area appears to be contained in porosity which is inaccessible in such times. Characterisation of the accessibility in different parts of the pore structure is intended to provide input data for models of radionuclide transport through clay geological barriers. Similar application is envisaged in connection with enhanced oil recovery. (author).

22549 (NUREG–1392) **Leakage of an irradiator source: The June 1988 Georgia RSI [Radiation Sterilizers, Inc.] incident.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Governmental and Public Affairs; Georgia Dept. of Natural Resources, Atlanta, GA (USA). Environmental Protection Div. Feb 1990. 45p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

On June 6, 1988, operators of a pool irradiator in Decatur, Georgia, were prevented by a safety system from raising sources from the pool. Radiation levels of 60 millirem per hour at the surface of the pool water were found, indicative of a leak of one or more of the 252 Cs-137 source capsules used at the irradiator. A summary of the Incident Evaluation Task Force's First Interim Report has been prepared for person's needing an overview of the incident and lessons learned to date. This report provides a summary of Agreement States' views and recommendations on some of the issues raised by the incident.

22550 (ORNL–6608) **Environmental regulatory update table, January 1990.** Houlberg, L.M.; Langston, M.E.; Nikbakht, A.; Salk, M.S. Oak Ridge National Lab., TN (USA). Feb 1990. 103p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90008024. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3447.

The Environmental Regulatory Update Table provides information on regulatory initiatives of interest to DOE operations and contractor staff with environmental management responsibilities. The table is updated each month with information from the Federal Register and other sources, including direct contact with regulatory agencies. Each table entry provides a chronological record of the rulemaking process for that initiative with an abstract and a projection of further action.

22551 (ORNL–6608/R1) **Environmental regulatory update table, February 1990.** Houlberg, L.M.; Langston, M.E.; Nikbakht, A.; Salk, M.S. Oak Ridge National Lab., TN (USA). Mar 1990. 109p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90008019. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3248.

The Environmental Regulatory Update Table provides information on regulatory initiatives of interest to Department of Energy (DOE) operations and contractor staff with environmental management responsibilities. The table is updated each month with information from the Federal Register and other sources, including direct contact with regulatory agencies. Each table entry provides a chronological record of the rulemaking process for that initiative with an abstract and a projection of further action.

22552 (ORNL/M–1029) **Environmental sciences division long-range plan: FY 1990 to FY 1994.** Oak Ridge National Lab., TN (USA). Mar 1990. 31p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90008763. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The mission of the Environmental Sciences Division (ESD) at Oak Ridge National Laboratory (ORNL) is to conduct environmental research and analyses associated with energy technology development and the interaction between man and the environment in support of US Department of Energy and ORNL goals. In support of this mission, ESD's goal is to be an international center of excellence in interdisciplinary environmental research for understanding and predicting environmental changes and for reducing risks. The plan serves as a framework and management guide for implementing actions to meet both scientific and operational objectives. These objectives include pursuing existing opportunities as well as establishing initiatives in the Division's six major programmatic areas: environmental toxicology, global environmental studies, landscape and ecosystem analysis, regulatory compliance and assessment, renewable resources, and waste research and development. Continued development of common values and objectives

among research and managerial staff is also encouraged in the plan. This report summarizes the objectives, together with the issues and challenges affecting them, and outlines the specific action plans designed to achieve these goals. 3 refs., 2 figs., 4 tabs.

22553 (PB–90-131657/XAB) **Leaching of heavy metals from thermally decontaminated soils.** Mooren, J.J.M.; van der Heide, J. Technische Hogeschool Delft (Netherlands). Dept. of Sanitary Engineering and Water Management. Mar 1989. 31p. (COMMUNICATION–29). Available from NTIS, PC A03/MF A01.

This report describes a research orientated at the effects on the environment due to the application of thermally decontaminated soils. Soil samples were taken from three thermally decontaminating plants. The composition of the soil, metal concentrations, and buffer capacity were determined to characterize the soils. The metal concentrations were compared with tentative reference values for unpolluted soils, which they did not meet fully. The leaching behavior was investigated using a tentative standard leaching test. The main conclusion of the investigation is, that all three soils can be applied without any restrictions, according to the present views. It was found that the soil with the lowest metal concentration gave the highest leaching percentage.

22554 (PB–90-137142/XAB) **Health assessment for Caldwell Trucking Company, Fairfield, New Jersey, Region 2. CERCLIS No. NJD048798953. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Oct 1988. 16p. Available from NTIS, PC A03/MF A01.

The Caldwell Trucking Company (Caldwell) National Priorities List Site is located in Fairfield Township, Essex County, New Jersey. Volatile organic compounds (VOCs) and polychlorinated biphenyls (PCBs) were detected in the soils and sediments sampled at the site. Low levels of VOCs were also detected in the surface water. The Record of Decision has not addressed the concerns for the surface water, the sediment, or the ground-water plume. The site is currently a potential public health concern.

22555 (PB–90-137225/XAB) **Health assessment for Cosden Chemical Coatings NPL (National Priorities List) site, Beverly, New Jersey, Region 2. CERCLIS No. NJD000565531. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jul 1988. 7p. Available from NTIS, PC A02/MF A01.

The Cosden Chemical Coatings Site is on the National Priorities List. The contaminants of concern at the site includes polychlorinated biphenyls, methylene chloride, chromium, lead, toluene, and ethyl benzene. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via on-site ingestion of contaminated soil and inhalation of chemical vapors and contaminant-entrained dust.

22556 (PB–90-137407/XAB) **Health assessment for Horstmann's Dump, East Hanover, New Jersey, Region 2. CERCLIS No. NJD981084577. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jul 1988. 7p. Available from NTIS, PC A02/MF A01.

The Horstmann's Dump is proposed for listing on the National Priorities List. A former operating landfill, located in East Hanover, New Jersey, the one-acre site allegedly received hazardous wastes from 1965 to 1973. Cadmium was reported in on-site soils. Off-site sediments contained polychlorinated biphenyls, toluene, polycyclic aromatic hydrocarbons, chlorobenzenes, and cadmium. Off-site surface water was found to contain nickel. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via soil and water.

22557 (PB–90-137506/XAB) **Health assessment for Myers Property, Franklin Township, New Jersey, Region 2. CERCLIS No. NJD980654198. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Meyers Property Site (MPS) is on the National Priorities List. MPS was a former pesticide manufacturing operation. Preliminary on-site surface and subsurface soil (24 inches below the surface) sampling results have identified organochlorine residues. They include DDT, DDD, and DDE. Dioxin was identified in soil (ND to 5 ppb). The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances via direct contact, ground water, and the food chain.

22558 (PB–90-137563/XAB) **Health assessment for Pijak Farm, Plumsted Township, New Jersey, Region 2. CERCLIS No. NJD980532808. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 3 Oct 1988. 9p. Available from NTIS, PC A02/MF A01.

The Pijak Farm Site is a National Priorities List site located approximately 2 miles northeast of the Town of New Egypt, in Plumsted Township, Ocean County, New Jersey. Certain areas of the farm served as disposal sites for a variety of industrial and domestic wastes. Industrial wastes, allegedly from Thiokol Corporation, were dumped into a natural ditch along the edge of a field and covered with soil. In addition, dumping took place in several areas adjacent to wooded and low-lying areas. The soil contaminants on-site included metals, phenolics, solvents, and polychlorinated biphenyl compounds (PCBs). Although the contamination is apparently not site-related, these wells should be reevaluated and if mercury contamination is confirmed, then actions to remove it should be developed and implemented.

22559 (PB–90-137589/XAB) **Health assessment for Reich Farm National Priorities List (NPL) site, Pleasant Plains, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980529713. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 25p. Available from NTIS, PC A03/MF A01.

The Reich Farm is a National Priorities List site located in the City of Pleasant Plains, Ocean County, New Jersey. Elevated levels of various organic compounds and heavy metals have been identified in on-site subsurface soils and in on-site and off-site ground water. The site is of potential public health concern because of the risk to human health that could result from possible exposures to hazardous substances at levels that may result in adverse health effects over time.

22560 (PB–90-137647/XAB) **Health assessment for Scientific Chemical Processing, Carlstadt, Bergen County, New Jersey, Region 2. CERCLIS No. NJD070565403. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The Scientific Chemical Processing site is on the National Priorities List. The six-acre site is a former waste-processing facility which accepted various wastes for recovery and disposal. On-site soil contamination (maximum concentrations reported) consists of volatile organic hydrocarbons (VOCs) (18,580 ppm); benzidine (244 ppm); petroleum hydrocarbons (81,600 ppm); polynuclear aromatic hydrocarbons (PAHs) 1,892 ppm; pesticides (264 ppm); polychlorinated biphenyls (PCBs) (15,000 ppm); and heavy metals. On-site ground water contamination (maximum concentrations reported) consists of VOCs (3,600 ppm); PCBs (17 ppm); PAHs (3 ppm); petroleum hydrocarbons (2,270 ppm); and heavy metals. The site is considered to be of potential public health concern because of the possibility of exposure to hazardous substances via contaminated ground water, soil, sediment, surface water, and air.

22561 (PB–90-137688/XAB) **Health assessment for Spence Farm, Ocean County, Plumsted Township, New Jersey, Region 2. CERCLIS No. NJD980532816. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Apr 1989. 11p. Available from NTIS, PC A03/MF A01.

The Spence Farm Site (Spence) is a National Priorities List site located in Plumsted Township, Ocean County, New Jersey. Certain areas of the farm served as disposal sites for a variety of industrial and domestic wastes. Industrial wastes, allegedly from Morton Thiokol Corporation, were dumped in scattered low-lying, wooded areas throughout the 30-acre site. The Record of Decision signed September 1984 mandated the removal and off-site disposal of all drums and lab packs, excavation and off-site disposal of visibly contaminated soil, construction of sediment controls during excavation and sampling efforts, and monitoring of on-site wells annually for 5

years. The removals have been completed. The site is of potential public health concern because of the potential risk to human health resulting from the possible exposure to hazardous substances via soil, sediment, ground water, surface water, air, and biota.

22562 (PB–90-137696/XAB) **Health assessment for Swope Oil Company, Pennsauken, Camden County, New Jersey, Region 2. CERCLIS No. NJD041743220. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

Swope Oil Company site is a National Priorities List site. Swope Oil Company, a chemical reclamation facility, was in operation from 1965 until December 1979 processing oils, paints, and other chemical compounds. The surface and subsurface soils and ground water are contaminated with polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), phthalate esters, and metals. The site poses a potential health concern for unauthorized persons entering the site, remedial workers, and railroad personnel who may work adjacent to the site. Also, the migration of contaminants into the ground water poses a potential health concern.

22563 (PB–90-137720/XAB) **Health assessment for Universal Oil Products National Priorities List (NPL) site, East Rutherford, New Jersey, Region 2. CERCLIS No. NJD002005106. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 10p. Available from NTIS, PC A02/MF A01.

The 75-acre Universal Oil Products property is located in East Rutherford, New Jersey. Aromatic chemicals were produced at the property beginning in 1932. Analyses of on-site soil samples show volatile organic compounds (VOCs) (e.g., benzene), polychlorinated biphenyls (PCBs), and heavy-metal (e.g., lead) contamination within the top four feet. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to hazardous substances via ingestion, inhalation, and direct dermal contact with contaminants in the soil, ground water, surface water, and sediment. There is also a possibility of exposure to hazardous substances via ingestion of contaminated biota.

22564 (PB–90-137746/XAB) **Health assessment for Ventron/Velsicol, Wood-Ridge Borough, Bergen County, New Jersey, Region 2. CERCLIS No. NJD980529879. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Ventron/Velsicol Site (VVS) is on the National Priorities List. The 40-acre site is located in Wood Ridge and Carlstadt Borough (Bergen County), New Jersey. VVS is a former chemical process operation. Preliminary on-site soil-sampling results have identified mercury (2 to 123,000 ppm), lead (92 to 5,710 ppm), cadmium (2 to 78 ppm), nickel (13 to 164 ppm), arsenic (less than 0.5 to 148 ppm), and zinc (42 to 128,454 ppm). In addition, mercury was also identified in surface water (1 to 16 ppm), sediment (147 to 4,480 ppm), and groundwater (1 to 30,890 ppb). The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances via direct contact and ingestion of soil, sediment, ground water, and surface water.

22565 (PB–90-137761/XAB) **Health assessment for Waldick Aerospace Devices, Monmouth County, New Jersey, Region 2. CERCLIS No. NJD054981337. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Feb 1988. 16p. Available from NTIS, PC A03/MF A01.

The 1.72-acre Waldrick Aerospace Devices site is located in Wall Township, Monmouth County, New Jersey. Surface soils and ground water are contaminated with volatile organic chemicals, petroleum hydrocarbons, chromium, and cadmium; building interiors are contaminated by a wide variety of process chemicals and pesticides. Although there are small, on-site areas with high concentrations of soil contaminants, the areas are vegetated and partially fenced to discourage trespassing. Access to these areas should be restricted until the soils are decontaminated or removed.

22566 (PB–90-138777/XAB) **Health assessment for Hooker/Ruco, Hicksville, New York, Region 2. CERCLIS No. NYD002920312. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1988. 16p. Available from NTIS, PC A03/MF A01.

The Ruco Polymer Corporation-Hicksville Facility, Nassau County, Hicksville, New York, formerly owned and operated by Hooker Chemical and Plastics Corporation is on the National Priorities List. Prior to 1980, process waste waters containing high concentrations of vinyl chloride, chlorinated solvents, alcohols, glycols, plasticizers and esters were discharged into leaching sumps at the facility. On-site soils and ground water underlying the site are contaminated. At several locations on-site, surface soils are contaminated with organic compounds. Soil samples taken at 1-2 feet depths revealed maximum concentrations of tetrachloroethene to be 244 mg/kg and PCBs (Arochlor 1248) to be 23,000 mg/kg. The site is considered to be of potential public health concern because of the risk to human health caused by possible exposure to hazardous substances via the ingestion and inhalation of contaminants present in the ground water. Exposure of on-site workers to contaminated soil and to volatilized organic chemicals emanating from the soil is also of concern.

22567 (PB–90-138785/XAB) **Health assessment for S-Area Landfill/Hooker, Niagara Falls, New York, Region 2. CERCLIS No. NYD000000001. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The S-Area Landfill is a National Priorities List site located in Niagara Falls, New York, that was operated from 1947 to 1975 by the Occidental Chemical Corporation (OCC). From 1947 to 1975, OCC is reported to have disposed of an estimated 19,000 tons of chlorobenzenes and approximately 17,000 tons of hexachlorocyclopentadiene. Other wastes disposed of at the site include organic phosphates, hexachlorobutadiene, trichlorophenols, and chlorinated toluenes. Environmental contamination from the S-Area exists on-site and off-site in soils and ground water. Further off-site contamination potentially exists in the Niagara River. The S-Area presents a potential public health threat to the consumers of the City of Niagara Falls drinking water and an incremental increase in contamination to fish in the Niagara River.

22568 (PB–90-138959/XAB) **Health assessment for Applied Environmental Services, Glenwood Landing, New York, Region 2. CERCLIS No. NYD980535652. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1988. 10p. Available from NTIS, PC A02/MF A01.

The Applied Environmental Services (AES)-Shore Realty site is located in the Town of Hempstead, Nassau County, New York. Although all the liquid chemicals stored in tanks and drums have been removed from the site, spills, leaks or other activities have left on-site soil, ground water and surface waters contaminated. On-site soils are contaminated with ethylbenzene and toluene. Ground water samples collected between 1984 and 1988 from nine on-site monitoring wells contained ethylbenzene, xylenes, and toluene. A sediment sample contained PCBs and other sediment samples contained ethylbenzene and xylene. The site is considered to be a potential health concern because of risk to human health caused by the possibility of exposures to site-related contaminants both on-site and off-site.

22569 (PB–90-139015/XAB) **Health assessment for Cortese Landfill, Sullivan County, Tusten, New York, Region 2. CERCLIS No. NYD980528475. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 14p. Available from NTIS, PC A03/MF A01.

The Cortese Landfill in the Town of Tusten, Sullivan County, New York is on the National Priorities List. Analytical data indicate that the contaminants of concern are arsenic, benzene, 1,2-trans-dichloroethene, 1,4-dichlorobenzene, 1,1-dichloroethane, toluene, xylene (all isomers), and vinyl chloride. The site poses a potential public health concern to residents living near the site and possibly to people using the Delaware River as a recreation source.

22570 (PB–90-139031/XAB) **Health assessment for F.M.C. Corporation, Orleans County, Shelby, New York, Region 2. CERCLIS No. NYD000511857. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Dublin Road Landfill Site is on the National Priorities List. Results of chemical analysis of soil samples collected from the waste-pile area in 1983 indicated the presence of arsenic, lead, various isomers of BHC, and DDT and its derivatives. The site poses a potential public health concern to area residents using private wells located downgradient from the site, users of Jeddo Creek Dublin Road, and, to a lesser extent, the users of the Barge Canal for recreational purposes.

22571 (PB–90-139122/XAB) **Health assessment for Marathon Battery, Cold Springs, New York, Region 2. CERCLIS No. NYD001959757. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Jul 1987. 15p. Available from NTIS, PC A03/MF A01.

The 11-acre Marathon Battery Site (MBS) Plant is located in Putnam County, Cold Springs, New York. The site is bordered to the east by a wooded area and to the south by a junkyard and Foundary Cove. Foundary Cove is a wetland marsh connected by several channels to the Hudson River. Various heavy metals have been identified on-site. They include arsenic, cadmium, cobalt, lead, nickel, and zinc. In addition, a previous ATSDR memorandum reports the results of a ground-water sample containing high concentrations of trichloroethylene. Based on the preliminary information reviewed concerning on-site and off-site contamination, MBS represents a potential public health threat to area residents.

22572 (PB–90-139130/XAB) **Health assessment for Jones Sanitation Landfill (Jones Septic Site), Hyde Park, Dutchess County, New York, Region 2. CERCLIS No. NYD980534556. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jul 1988. 7p. Available from NTIS, PC A02/MF A01.

The Jones Sanitation Landfill, also known as the Jones Septic Site, is listed on the National Priorities List. From the early 1960s through 1979 the site accepted industrial liquid wastes and sludges. The site now accepts only septic waste collected by commercial firms. Results of environmental sampling indicate that the contaminants of concern at the site include inorganics (e.g., chromium, copper, lead, cadmium, mercury), oil and grease wastes, and several volatile organic chemicals including: 1,1-dichloroethylene; trichloroethylene; trichloroethene, acetone; 1,2,4-trichlorobenzene; chloroform; methylene chloride; and perhaps pentachlorophenol. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via the above-named human exposure pathways.

22573 (PB–90-139973/XAB) **Health assessment for General Electric Wiring Devices, Juana Diaz, Puerto Rico, Region 2. CERCLIS No. PRD090282757. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Mar 1988. 12p. Available from NTIS, PC A03/MF A01.

The General Electric Wiring (GEW) Devices Site is located in Juana Diaz, Puerto Rico. Activities at the site primarily involved production of electrical devices, including switch buttons containing elemental mercury. Broken buttons, containing traces of mercury, were discarded in the waste fill at GEW over a period of 20 years. Mercury was later found to be present in the upper 2-3 feet of soil in the waste fill, and also in the surface soils to the west and south of the fill. Trichloroethylene was also used at the site and on one occasion was observed in ground water. A residential area exists a few hundred feet south of the fill area and its population and others in the general area are potentially at risk from the contaminants through exposure to ground water and contact with contaminated soils.

22574 (PB–90-139999/XAB) **Health assessment for Fibers Public Supply Wells, Guayama, Puerto Rico, Region 2. CERCLIS No. PRD980763783. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Fibers Public Supply Wells Site is a former synthetic fiber manufacturing plant located in Guayama, Puerto Rico. Currently, a pharmaceutical manufacturing facility operates on-site. In addition, 5 public supply wells exist on-site. Preliminary on-site sampling results have identified acetone (7 to 2,260 ppb in soil), methyl ethyl ketone (ND to 7 ppb in soil), ethylene chloride (ND to 55 ppb in soil), bis(2-ethyl hexyl)phthalate (ND to 1,060 ppb in soil). On-site monitoring-well-sampling results identified perchloroethylene (ND to 198 ppb), trichloroethylene (ND to 18 ppb), vinyl chloride (ND to 28 ppb), and trichlorofluoromethane (ND to 10 ppb). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact with and ingestion of contaminated soil by pharmaceutical employees and possibly area residents who access the site are the most likely exposure pathways. In addition, ingestion and direct contact with ground water may possibly be another exposure route.

22575 (PB–90-140443/XAB) **Health assessment for Pasley Solvents and Chemical, Garden City, New York, Region 2. CERCLIS No. NYD991292004. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Pasley Solvents and Chemicals site, a National Priorities List site, is located in the Town of Hempstead, immediately east of the Village of Garden City in Nassau County, New York. Between 1969 and 1982, Pasley operated a chemical distribution facility on the lot, occasionally storing waste chemicals. Prior to this, Commander Oil used the site for gasoline storage and fuel oil distribution. The Nassau County Health Department (NCHD) investigated the site in 1981 and found the on-site soil and ground water to be contaminated with organic solvents and petroleum products. On-site sampling by NCHD and the owner has revealed organic chemicals and petroleum products in both soil and ground water. Six chlorinated solvents and four aromatic compounds are in ground water above the part per million. The site is a potential threat to public health.

22576 (PB–90-855958/XAB) **Ground subsidence due to mining operations. October 1976-November 1989 (Citations from the COMPENDEX data base). Report for October 1976-November 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 93p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning ground subsidence associated with mining operations. Mine subsidence is discussed with reference to mathematical modeling, forecasting extent of cavitation, and rock mechanics and mechanisms of stress relaxation. Damage to above- and below-ground structures as well as agricultural areas, and mining techniques designed to prevent or reduce subsidence are included. Monitoring of subsidence and detection of cavitation for surface, underground, and ocean-floor mining areas are discussed and examples are analyzed. Subsidence due to aquifer water removal is referenced in a related published bibliography. (Contains 213 citations fully indexed and including a title list.)

22577 (PNL–6100-Pt.4, pp. 11-12) **Continuous-wave double-resonance ionization mass spectrometry.** Whitaker, T.J.; Cannon, B.D.; Gerke, G.K.; Bushaw, B.A. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Pacific Northwest Laboratory is developing laser-based methods for measuring low levels of toxic materials and environmentally hazardous substances. In the last year, development of continuous-wave double-resonance ionization mass spectrometry has been continued. That technique combines isotopically selective ionization with mass spectrometry to provide improved discrimination against isobaric interferences. Continuous-wave (cw) lasers offer two distinct advantages over pulsed lasers in analytical applications; they typically have narrower bandwidths by 3 to 4 orders of magnitude, and they have unity duty cycle. A technique has been developed that employs two cw dye lasers to sequentially excite an atomic species to a high electronic state. The excited atoms are then photoionized by a powerful infrared laser. The cw dye lasers have very high-wavelengths resolution and can be tuned to a specific isotope of the target element. This technique, with its combination of mass selectivity from the mass spectrometer with isotopic selectivity in the laser ionization step, makes

possible the analysis of the isotopic abundances of 10^{11} and greater. The sensitivity has been improved by exciting the atom to a higher electronic state and using a CO_2 laser for photoionization. This method is significantly better than most ionization techniques used in mass spectrometry and provides the added advantage of elemental and isotopic selectivity.

22578 (PNL–7116) **Radon transport in dry, cracked soil: Two-dimensional, finite element model.** Holford, D.J. (Pacific Northwest Lab., Richland, WA (USA)); Schery, S.D.; Wilson, J.L.; Phillips, F.M. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 116p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90008099. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A two-dimensional finite element code, CRACK, simulates the effect of changes in surface air pressure on radon concentration in soil with parallel, partially penetrating cracks. A sensitivity analysis investigates the effect of changes in crack dimensions, soil characteristics, and surface air pressure on radon flux to the atmosphere from a dry, cracked soil. Radon flux is found to be most sensitive to changes in soil properties: the diffusion coefficient is most important, followed by permeability and porosity. Radon flux is also sensitive to changes in barometric pressure. Cracks have a more significant effect on radon flux from soils of low permeability. The effects of moisture should be considered in future studies, because of moisture's importance to the effective air-filled porosity, air permeability, and diffusion coefficient of soils.

22579 (PSI–53) **Modelling of a diffusion-sorption experiment on sandstone.** Smith, P.A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Nov 1989. 28p. Order Number DE90619465. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of a diffusion-sorption experiment on a sample of Darley Dale sandstone, using simulated groundwater spiked with a mixture of ^{125}I, ^{85}Sr and ^{137}Cs, are modelled by a one-dimensional porous medium approach in which sorption is described by Freundlich isotherms. The governing equations are solved analytically for the special case of a linear isotherm, and numerically using the computer code RANCHDIFF for non-linear isotherms. A set of time-dependent, ordinary differential equations is obtained using the Lagrange interpolation technique and integrated by Gear's variable order predictor-corrector method. It is shown that the sorption behaviour of ^{85}Sr can be modelled successfully by a linear isotherm, using a sorption parameter consistent with batch-sorption tests. The behaviour of ^{137}Cs may be modelled by a non-linear isotherm, but the amount of ^{137}Cs sorbed is less than that anticipated from batch-sorption tests. ^{125}I is assumed to be non-sorbing and is used to determine the porosity of the sandstone. (author) 10 figs., 4 tabs., 6 refs.

22580 (PSI–54) **Radionuclide chain transport with matrix diffusion and non-linear sorption.** Jakob, A. (Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Programm Entsorgung); Hadermann, J.; Roesel, F. Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Nov 1989. 64p. Order Number DE90619466. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The present paper describes a two-dimensional model for radionuclide transport in inhomogeneous rock. Advective and dispersive flux takes place in water conducting zones which may consist of a network either of tubelike veins or planar fractures. Out of these flowpaths nuclides diffuse into stagnant pore water of a spatially limited, adjacent zone (matrix diffusion). Sorption on rock surfaces is described by a non-linear isotherm. Under specific conditions matrix diffusion can be represented by an effective (non-linear) surface sorption. Radioactive decay and, in the case of a nuclide chain, ingrowth is also included in the model. The numerical solutions of transport equations based on the method of lines are developed in detail. The advantages of this approach are the efficiency, the reliability and the general flexibility especially to include arbitrary boundary and initial conditions and arbitrary solute/rock interactions. For ^{135}Cs we present in a comprehensive sensitivity analysis the impact of non-linear (Freundlich) sorption isotherm on break-through curves. It is shown that, provided transport times are comparable or larger than nuclide half-life, non-linear sorption may reduce concentrations at the geosphere outlet by orders of magnitude. Some results are also given for the transport of the ^{238}U chain. (author) 25 figs., 2 tabs., 27 refs.

22581 (RFP-ENV–88) **Rocky Flats Plant site environmental report for 1988, January through December 1988.** Daugherty, N.M. (ed.). Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. May 1989. 95p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP03533. Order Number DE90006469. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report documents the 1988 environmental surveillance program at the Rocky Flats Plant. The report includes an evaluation of plant compliance with all appropriate guides, environmental limits, and standards. Potential radiation dose to the public was calculated from average radionuclide concentrations measured at the plant property boundary and in surrounding communities. 37 refs., 14 figs., 32 tabs.

22582 (STUK-A–76) **Environmental gamma radiation and fallout measurements in Finland, 1986-87: Supplement 2 to annual report STUK-A-74.** Arvela, H.; Markkanen, M.; Lemmelae, H.; Blomqvist, L. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Jul 1989. 32p. Order Number DE90619462. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Results from a survey of environmental gamma radiation levels in Finland after the Chernobyl accident 1986 are presented. The measurements were made in 1986-87 by means of sensitive Geiger-counters and a gamma-spectrometer placed in cars. The results show the level of external radiation caused by the cesium fallout on the first of October 1987. The fallout pattern of ^{137}Cs as well as of ^{95}Zr and ^{103}Ru are also presented. In the center of Southern Finland there are wide areas with exposure levels exceeding 0.03 $\mu Sv\ h^{-1}$, areas exceeding 0.10 $\mu Sv\ h^{-1}$ being very rare. The surface area weighted mean dose rate for the 461 municipalities in Finland was 0.027 $\mu Sv\ h^{-1}$ (range 0-0.19 $\mu Sv\ h^{-1}$). The population weighted mean dose rate was 0.037 $\mu Sv\ h^{-1}$. The corresponding estimated surface activity of ^{137}Cs was 10.7 kBq m^{-2}. The passage of the Chernobyl plume over Finland in 1986 led to various fallout patterns for different radionuclides. The deposition of the non-volatile nuclides, ^{95}Zr and ^{141}Ce, is closely related to the passage of the hot particle dust formed at the initial explosion in the reactor at 01.23 LT on 26 April. This cloud passed over Finland between the morning and the night of 27 April. The deposition of volatile fission products such as ^{131}I, ^{132}Te, ^{134}Cs and ^{137}Cs in Finland was caused by releases from the burning reactor after the initial explosion. The radioactive plume spread over Southern and Central Finland between Sunday 27 April and Tuesday 29 April. On 30 April and finally on 1 May a could northerly airstream spread into the whole of Finland purifying the atmosphere. The volatile nuclides were mainly deposited by intermittent rain on 28-30 April. (Abstract Truncated)

22583 (STUK-A–84) **Radioactivity of sludge in Finland in 1987: Supplement 10 to annual report STUK-A-74.** Puhakainen, M.; Rahola, T. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). May 1989. 27p. Order Number DE90619467. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Sewage sludge from municipal wastewater treatment plants was studied to determine its radionuclide concentrations. Measurements were made to find out whether any radionuclides from the nuclear power stations at Loviisa and Olkiluoto and from hospitals and medical laboratories could be detected in sludge additional to those originating from global and Chernobyl fallout. In the treatment process of water, aluminium sulphate sludge is developed at treatment plants using surface water. This kind of sludge was measured since it also concentrates radionuclides. Fallout nuclides from the Chernobyl nuclear power station after the accident predominated in all sewage sludge samples in Finland. In 1987 six different radionuclides originating from the Chernobyl fallout were detected in sewage sludge. In spring when the snow melted and large quantities of run off water flowed into the treatment plants, the activity concentrations clearly increased, but then started decreasing again. At the end of the year the highest measured ^{137}Cs activity concentrations were below 1000 Bq kg^{-1} dry weight. The

highest activity concentration in sludge originated from iodine used fro medical purposes.

22584 (VR–88-05, pp. 312-314) **BILTH: A radiation-burden model for the contamination pathway air-grass-cow-milk.** . Blaauboer, R.O. Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. (In Dutch). In *Reports from the RIVM 1987.* Order Number DE90619668. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The Bilthoven model calculates the contamination of milk via the air-grass-cow-milk pathway after a nuclear accident. For I-131 the calculation was performed for 13 locations partitioned over the Northern Hemisphere and contaminated more or less by 'Chernobylsk'. With the measured concentrations I-131 in grass and milk the model was validated. 2 refs.; 4 figs.; 1 tab.

22585 (WINCO–1071) **ICPP [Idaho Chemical Processing Plant] environmental monitoring report, CY-1988.** Krivanek, K.R. Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (USA). Aug 1989. 53p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-84ID12435. Order Number DE90008032. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Summarized in this report are the data collected through Environmental Monitoring programs conducted at the Idaho Chemical Processing Plant (ICPP) by the Environmental Engineering (EE) Section of the Nuclear and Industrial Safety (N and IS) Department. The ICPP is responsible for complying with all applicable Federal, State, Local and DOE Rules, Regulations and Orders. Radiological effluent and emissions are regulated by the DOE. The Environmental Protection Agency (EPA) regulates all nonradiological waste resulting from the ICPP operations including all airborne, liquid, and solid waste. The EE subsection completed a Quality Assurance (QA) Plan for Environmental Monitoring activities during the third quarter of 1986. QA activities have resulted in the ICPP's implementation of the Environmental Protection Agency rules and guidelines pertaining to the collection, analyses, and reporting of environmentally related samples. Where no approved methods for analyses existed for radionuclides, currently used methods were submitted for the EPA approval. 33 figs., 14 tabs.

22586 Role of ductile shearing in the concentration of radon in the Brookneal zone, Virginia. Gates, A.E. (Rutgers Univ., Newark, NJ (USA)); Gundersen, L.C.S. *Geology (USA),* 17(5): 391-394 (May 1989).

A positive correlation exists among surface gamma radiation, uranium concentration, and the angles between C and S bands in mylonite and radon in the soils overlying the Brookneal zone of the southwest Virginia Piedmont. Part of the Brookneal zone lies within the compositionally homogeneous Melrose granite, which is undeformed to the west of the zone. The angle between C and S bands in mylonitic Melrose granite varies from 43° in the westernmost protomylonte to near 0° in the easternmost ultramylonite. Radon in the overlying soils increase from 450 picocuries/litre (pCi/L) in underformed granite to as much as 4100 pCi/L in ultramylonite. In undeformed granite, uranium is hosted in titanite and zircon. During mylonitization, uranium was redistributed into the foilation and is associated with hematite and fine-grained monazite. Uranium, however, is in constant proportion to thorium, indicating little introduction of new uranium into the mylonite zone. An increase in the uranium concentration from 1 to 2 ppm in undeformed granite to 7 to 8 ppm in ultramylonite may be the result of volume loss during shearing.

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Refer also to citation(s) 21327, 21329, 21330, 21516, 21517, 21538, 21541, 21542, 21543, 21544, 21545, 21546, 21602, 21603, 21604, 21605, 21606, 21607, 21627, 21668, 21901, 22051, 22294, 22493, 22521, 22522, 22525, 22535, 22549, 22554, 22558, 22559, 22560, 22561, 22562, 22563, 22564, 22565, 22566, 22567, 22568, 22569, 22570, 22571, 22572, 22573, 22574, 22575, 22585, 22767

22587 (AD-A–214557/1/XAB) **Initiation decision report: Nonpoint source discharge. Technical note (Final), July 1987-June 1988.** Karr, L.; Heath, J.C. Naval Civil Engineering Lab., Port Hueneme, CA (USA). Aug 1989. 60p. (NCEL-TN–1798). Available from NTIS, PC A04/MF A01.

Under recent amendments to the Clean Water Act, the Navy must be responsible to State's authority in the control of nonpoint sources (NPS) of water pollution. Nonpoint sources are pollutants that do not originate from a single, well-defined source and are initially transported by the natural hydrological system. The sources are diffuse in nature, ranging from storm-water run-off with no single identifiable endpoint, to leachate from abandoned waste sites. The most common Navy nonpoint sources of pollution include storm water run-off from agricultural and range-land leases, construction areas, industrial areas, residential and commercial areas, impact zones, and training areas.

22588 (AD-A–215040/7/XAB) **Environmental feasibility of using wetlands to treat runoff pollution. Final report.** Gadbois, L.E. Naval Ocean Systems Center, San Diego, CA (USA). Oct 1989. 37p. (NOSC/TR–1321). Available from NTIS, PC A03/MF A01.

Chemical and ecological characteristics of wetland types commonly occurring in and around Navy bases are reviewed. The natural wetland processes are examined from the perspective of their capacity to remediate nonpoint source pollution (NPSP). The ecological habitat value of wetlands is iterated, as are the habitat value changes resulting from pollution loading. Five generic pollutant categories of NPSP are discussed: biochemical oxygen demand (BOD), nutrients, suspended particulates, heavy metals, and organics (petroleum, solvents, biocides). The ecological consequences of each pollutant category, the treatment principles for this pollutant category, and how wetlands can provide the necessary treatment conditions are discussed. Choice of the correct wetland morphology is important for effective NPSP remediation. Guidelines for choosing an existing marsh or construction of a new marsh are provided. A tidal salt marsh construction proposal is reviewed to determine the ecological validity, the expected remediation effectiveness, the side effects, and the legal requirements for the construction. The state of the science is still too immature to confidently predict the effectiveness of the marsh at this site. The indications are that insufficient residence time of the water pollutants will minimize the effectiveness. Also, the varied and dynamic exchanges between the marsh and the adjacent water body will hamper efforts to quantitatively determine the level of remediation.

22589 (AI–89-06172) **Water supply constraints to energy development, phase 7: Summary report.** Acres International Ltd., Toronto, ON (Canada). Jul 1988. 155p. (MICROLOG–89-06172). Available from PC WATDOC (Canada), Inland Waters Directorate, Environment Canada, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Inland Waters/Lands, Environment Canada, has progressively been developing a comprehensive capability for evaluating water supply constraints to energy development in Canada. The present work describes further development of the graphics capabilities, enhancements to the industrial water use and demand/price analysis routines, a number of data processing inprovements, expansions of the data base on the Waterton/Saint Mary reservoir in southern Alberta and on the Saskatchewan River Basin, and scenario evaluations for the Saskatchewan River Basin in Alberta and Saskatchewan; supply availability is shown to be a serious problem in the Battle River basin and in the small sub-basins that are modelled separately. Recommendations are given as to future improvements of the model and the data base of reservoir operating policies. 17 refs., 39 figs., 35 tabs.

22590 (CONF-8904311–1) **Trend detection in the presence of covariates: Stagewise versus multiple regression.** Smith, E.P. (Kent Univ., Canterbury (UK). Mathematics Inst.); Rose, K.A. Oak Ridge National Lab., TN (USA). [1989]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1. international environmetrics conference; Cairo (Egypt); 3-7 Apr 1989. Order Number DE90006147. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The assessment of trend in water quality is an important task for environmental managers and scientists. An important problem

discussed in this paper is that of the underlying models and mechanisms that relate the water quality time series to other time dependent covariates. There are two basic approaches for the adjustment for covariates that may be used in trend assessment, stagewise regression and multiple regression. By using simulation, analysis and a data set from the Chesapeake Bay, USA, the approach based on stagewise regression is shown to lead to erroneous results in some situations. The method that performs better in these cases is multiple regression which has more power in general than the stagewise method. 10 refs., 4 tabs.

22591 (CONF-9004144–1) **Design of a simulation interface for a parellel computing environment.** Narang, H. (Tuskegee Univ., AL (USA). Dept. of Computer Science); Flanery, R.; Drake, J. Oak Ridge National Lab., TN (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Annual ACM south eastern region conference; Atlanta, GA (USA); 13 Apr 1990. Order Number DE90008497. Available from NTIS, PC A03/MF A01 - OSTI.

A user interface for simulation of contaminant transport in groundwater flow using a distributed memory parallel processor is described. The user interface is a menu-mouse driven presentation using the X-Windows software. To facilitate the division and distribution of data among processors and to develop a data structure capable of manipulation for a variety of functions, graphics, remeshing, input and retrieval of auxiliary information, an object oriented programming style is used. The parallel computational model for the update of contaminant concentrations is organized around objects and an explicit time marching algorithm implemented on an IPSC2 Hypercube multiprocessor. 6 refs.

22592 (DOE/ER/60161–T1) **Water Science and Technology Board annual report, 1988.** Parker, S.D. National Research Council, Washington, DC (USA). Water Science and Technology Board. 1990. 70p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-83ER60161;FG05-89ER60743. Order Number DE90007434. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This annual report of the Water Science and Technology Board (WSTB) summarizes the activities of the Board and its subgroups during 1988, its sixth year of existence. Included are descriptions of current and recently completed projects, new activities scheduled to begin in 1989, and plans for the future. The report also includes information on Board and committee memberships, program operational features, and reports produced during the past several years. This annual report is intended to provide an introduction to the WSTB and summary of its program for the year.

22593 (DOE/ER/60161–T2) **Water Science and Technology Board annual report, 1987: Annual report, 1987.** National Research Council, Washington, DC (USA). Water Science and Technology Board. 1988. 66p. Sponsored by U.S. DOE Energy Research; U.S. Department of the Interior; Environmental Protection Agency; Electric Power Research Institute; U.S. Federal Emergency Management Agency; Ford Foundation; Nuclear Regulatory Commission; National Science Foundati DOE Contract FG01-83ER60161. Order Number DE90007438. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In 1982, the National Research Council chose to recognize the importance of water resource issues by establishing the Water Science and Technology Board (WSTB). During the five years since its first meeting in November 1982, the WSTB has grown and matured. The WSTB has met 14 times to provide guidance and plan activities. Under the WSTB's direction, committees of experts have conducted approximately 30 studies on a broad array of topics, from dam safety to irrigation-induced water quality problems to ground water protection strategies. Studies have ranged in scope from the oversight of specific agency projects and programs to broader scientific reviews, such as a disciplinary assessment of the hydrologic sciences initiated in 1987. In all cases, studies have the general theme of ultimately improving the scientific and technological bases of programs of water management and environmental quality. Several hundred people have played active roles in these studies. WSTB reports have had and are having important effects, and the WSTB's credibility and visibility have increased with each successive project during its five-year history. The WSTB has proven itself to be a thorough and credible source of advice for the water resources community.

22594 (DOE/ER/60161–T3) **Water Science and Technology Board annual report, 1986: Annual report, 1986.** National Research Council, Washington, DC (USA). Water Science and Technology Board. 1987. 63p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Department of the Interior; Environmental Protection Agency; U.S. Federal Emergency Management Agency; Nuclear Regulatory Commission; National Science Foundation; State of California; DOE Contract FG01-83ER60161. Order Number DE90007437. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This fourth annual report of the Water Science and Technology Board summarizes the Board's accomplishments during 1986, its current activities, and its plans for the future. The report also includes information on Board and study group memberships, program organization, and reports produced. The Water Science and Technology Board is a unit of the National Research Council, the operating arm of the National Academy of Sciences that exists by virtue of an 1863 act of Congress, instructing it to provide scientific and technological assistance to the federal government. The Board is independent of the federal government, and participants in Board activities serve without compensation. The expertise and resources available to the Board extend across many disciplines and types of organizations concerned with water and related resources. The Board's independence and the resources available to it afford a unique and effective forum for addressing cohesively various important issues on the national water resources agenda. The volunteers who serve the Water Science and Technology Board and the Board's federal agency liaison representatives are the constituency on which it depends for the quality of its work in response to those who seek its advice. In 1986, several hundred individuals participated in Board activities in various capacities.

22595 (DOE/ER/60161–T4) **Water Science and Technology Board annual report, 1985: [Final report].** National Research Council, Washington, DC (USA). Water Science and Technology Board. 1986. 57p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Department of the Interior; Environmental Protection Agency; U.S. Federal Emergency Management Agency; Nuclear Regulatory Commission; National Science Foundation; U.S. Geological Surv DOE Contract FG01-83ER60161. Order Number DE90007436. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This is the third annual report of the Water Science and Technology Board. The report summarizes the Board's activities during 1985, ongoing activities, and plans for the future. Included also is information on Board and study group memberships, program organization, issues of concern, and reports produced. The Water Science and Technology Board is a unit of the National Research Council (NRC), part of the National Academy of Sciences that exists by virtue of an act of Congress in 1963 instructing it to provide scientific and technological assistance to the federal government. The Board is independent of the federal government, and participants in board activities serve without compensation. The expertise and resources available to the Board extend across many disciplines and types of organizations concerned with water and related resources. The Board's independence and the availability of resources to it afford a unique and effective forum to address cohesively the variety of issues on the national water resources agenda. The volunteers who serve the Water Science and Technology Board and the Board's federal agency liaison representatives are the constituency on which it depends for the quality of its work in response to those who seek its advice. In 1985, several hundred individuals participated in Board activities in various capacities.

22596 (DOE/ER/60161–T5) **Water Science and Technology Board annual report, 1984: [Final report].** National Research Council, Washington, DC (USA). Water Science and Technology Board. 1985. 50p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Department of the Interior; Environmental Protection Agency; U.S. Federal Emergency Management Agency; National Science Foundation; U.S. Geological Survey;

William H. Donner Foundatio DOE Contract FG01-83ER60161. Order Number DE90007435. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This is the second annual report of the Water Science and Technology Board (WSTB), a unit of the National Research Council (NRC). It summarizes the Board's activities during 1984, ongoing activities (i.e., in 1985), and future plans. Information is included also on Board and study group memberships, program organization, issues of concern, and reports published. For the Water Science and Technology Board, 1984 was marked by several significant events and achievements, and the Board's program for the year must be considered successful. A number of important new activities were undertaken, including a study of the technical and institutional aspects of state and local ground-water protection programs and an assessment of flood and earthquake criteria to be used in the evaluation of the safety of dams. In cooperation with the Royal Society of Canada, a study committee of the Board is reviewing the Great Lakes Water Quality Agreement, with the report likely to make recommendations for consideration by the US and Canadian governments if they renegotiate the Agreement in 1986. A new, standing Committee on Water Resources Research was established to assist the Department of the Interior, through the US Geological Survey, in carrying out its responsibilities under the Water Resources Research Act of 1984 and to assist the Survey and the Board with other water research-related matters.

22597 (DOE/ER/60470–1) **Hypotheses testing of watershed/landscape dynamics in northern Alaska using digital analysis: Final report, July 15, 1986–July 14, 1989.** Evans, B.M.; Petersen, G.W.; Connors, K.F. Pennsylvania State Univ., University Park, PA (USA). Environmental Resources Research Inst. Sep 1989. 113p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60470. Order Number DE90006721. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Since July of 1985, Penn State scientists have been cooperating with investigators from other universities in several ecosystem studies at an existing Department of Energy (DOE) study site on the North Slope of Alaska. The primary focus of the REFLEX program is to test new applications of remote sensing systems and allied digital database processing techniques for studying hydrologic/ecologic interactions. One of the goals of this particular REFLEX project was to complement ongoing R4D studies near Toolik Lake. Since their initial cooperative efforts with R4D investigators at the R4D study site in Phase I, scientists (primarily G. Petersen and B. Evans), have been intimately involved with the Landscape Ecology Working Group, one of several such groups established within the R4D program. As part of the R4D program, the Landscape Ecology Working Group is focusing on landscape-scale patterns and interactions that have applications to long slopes, watersheds, and large regions of the Alaskan North Slope.

22598 (DOE/OR/00033–T432) **Effects of environmental and physiological variables on the uptake of hydrophobic contaminants by the gills of rainbow trout, Salmo gairdneri (Richardson).** Black, M.C. Oak Ridge National Lab., TN (USA). May 1989. 126p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-76OR00033. Order Number DE90007697. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The uptake of contaminants by diffusion across fish gills may be altered by changes in the contaminant's physicochemical form or changes in fish respiration. This study investigated the effects of changes in contaminant uptake due to sorption to humic acid and changes in fish respiration, induced by altering respiratory demand via an acute change in temperature and by altering the diffusional capacity of the gill membrane by exposure to chlorine. In each experimental design the uptake of selected polycyclic aromatic hydrocarbons and polychlorinated biphenyl congeners by the gills of rainbow trout, were measured simultaneously with measurements of fish respiratory functions using a fish metabolic chamber. 110 refs., 19 figs., 7 tabs.

22599 (DOE-RW–89.066) **Studies of environmental radioactivity in Cumbria - Pt. 18: Plutonium and americium behaviour in Cumbrian near-shore waters.** McKay, W.A. (UKAEA Harwell Lab. (UK). Environmental and Medical Science Div.); Walker, M.I. Department of the Environment, London (UK). Apr 1989. 34p. (AERE-R–13441). Order Number DE90619474. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Final report.

A small fraction of the radionuclides discharged into coastal waters is blown back onto land in seaspray. Man is exposed directly through inhalation of the spray and indirectly via inhalation of resuspended soil and consumption of food stuffs. Sea to land transfer is most readily observed in Cumbria, and for the actinides plutonium and americium, where doses at the μSv year^{-1} level result. Another exposure route for some members of the population of the Cumbrian coast is the ingestion of actinides in seafood, particularly in winkles. In predicting the magnitude of sea to land transfer and uptake in seafood and their radiological consequence in the short and long term, some understanding of the processes controlling radionuclide levels in the adjacent near-shore waters is necessary. A recent study of Pu and Am concentrations in the coastal waters near Sellafield, Cumbria is described and discussed in this report. The results suggest that the actinides remain available for sea-to-land transfer in these near-shore waters for more than 6 years following their discharge from Sellafield. During this time, variations in suspended particulate loadings appear to be the most important influence on the seawater concentration. (author).

22600 (GKSS–89/E/25) **Small scale patches of suspended matter and phytoplankton in the Elbe river estuary, German Bight and tidal flats.** Doerffer, R. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)); Fischer, J.; Stoessel, M.; Brockmann, C.; Grassl, H. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 11p. Available from Special print from Adv. Space Res. (1989) v. 9(1) p. 191-200.

Thematic mapper and ship data has been used to study small scale features in coastal waters of the North Sea. Three independent pieces of informations from all 7 TM channels were found with factor analysis: suspended matter concentration, atmospheric scattering and sea surface temperature. Near surface suspended matter concentrations may be detected within a factor of 2. For the required atmospheric correction the signal-to-noise ratio of the channels 5 and 7 has to be improved by averaging over 25 x 25 pixels. Thus TM allows to monitor aerosol optical depth and aerosol type over cloudfree water surfaces. Sea surface temperature is retrievable with an absolute accuracy of 1.0 K as long as radiosonde data are available for the correction of atmospheric effects, while relative temperature variations of 0.5 K are detectable. The patchiness of suspended matter and its relation to underwater topography was analysed with auto- and crosscorrelation: horizontal lengths, where the suspended matter concentration of single pixels are significantly correlated either with each another or with water depth, are < 800 m. (orig.).

22601 (GKSS–89/E/26) **Strontium-90 and cesium-137 in the Elbe river before and after the Chernobyl accident.** Wilken, R.D.; Diehl, R. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 18p. (In German). Available from Special print from Vom Wasser, VCH Verlagsges. (1989) v. 72 p. 65-81.

Sr-90 and Cs-137 were analysed in monthly mixed samples at four stations in the Elbe river. The average Sr-90 concentration before the Chernobyl accident in the unfiltered water was approximately 0.015 Bq/l, increasing during June 1986 to 0.05 Bq/l. The average Cs-137 concentration was about 0.001 Bq/l in the inner estuary; due to emissions from reprocessing plants in Great Britain and France the concentration in the outer estuary was about a factor of 10 higher. The Cs-137 concentration was increased by the Chernobyl emissions to 0.1-0.5 Bq/l from May to July 1986, and is now again in the range of the values measured before the accident. A rough estimate of the amounts transported into the North Sea from May to July 1986 are 150-300 GBq for Sr-90 and 500-2000 GBq for Cs-137. Since sampling for Cs-137 was probably not representative, this figure could be a factor of 2-5 higher. These values are small compared to the natural radioactivity of K-40, and to the amounts of Cs-137 emitted by the reprocessing plants in Sellafield/Windscale and La Hague. (orig.).

22602 (IAEA-R–4390-F) **Cycling of the main natural alpha emitters in the coastal marine environment: Final report for the period 1 March 1986 - 30 June 1989.** Bettencourt, A.O. Laboratorio Nacional de Engenharia e Tecnologia Industrial, Sacavem (Portugal). Dept. de Proteccao e Seguranca Radiologica; International Atomic Energy Agency, Vienna (Austria). Nov 1989. 12p. Order Number DE90617511. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A suite of natural radionuclides including ^{210}Pb-^{210}Po was analysed in atmospheric deposition, seawater, suspended particulates and abyssal fauna from the NE Atlantic Ocean. Measurements of dry and wet atmospheric fallout show that most of the ^{210}Pb and ^{210}Po in surface seawater originates from atmospheric deposition. In surface seawater near Madeira, ^{210}Pb and ^{210}Po concentrations average 2.1±0.7 and 1.5±0.7 mBq l^{-1}, respectively. ^{210}Pb was in excess of ^{226}Ra in the upper mixed layer but below 500 m the ^{210}Pb/^{226}Ra ratio was less than 1 due to preferential scavenging of ^{210}Pb by particles. Seawater profiles of ^{210}Po and ^{210}Pb indicated a well-defined maximum of ^{210}Po between 250-500 m. Based on activity levels measured in water and suspended particulates in the Iberian and Porcupine abyssal basins, mean residence times of 5 y and 1 y were computed for soluble ^{210}Pb and ^{210}Po, respectively. A shorter residence time of 0.6 y was computed for the particles that scavenge both radionuclides. Analysis of a variety of abyssal organisms demonstrated a wide range in whole-body ^{210}Po concentrations with values varying between 38 Bq kg^{-1} (wet wt.) in ascidians to 174 Bq kg^{-1} wet in starfish. The lowest concentrations (0.37 Bq kg^{-1} wet) were found in the muscle of the rattail Coryphaenoides armatus. In mesopelagic fish muscle ^{210}Po concentrations ranged from 0.2 Bq kg^{-1} wet in Aphanopus carbo to 980 Bq kg^{-1}1 wet in the hatchet fish Argyropelecus aculeatus. In the hatchet fish a very high concentration of 7.9 kBq kg^{-1} wet in gonad results in a dose of 4.2 Sv y^{-1} to that organ. In general, the ^{210}Po concentrations measured in abyssal and mesopelagic species are similar to those which have been reported for coastal organisms.

22603 (LBL–28207) **Bare soil evaporation at Kesterson Reservoir, Merced County, California: Estimation by physical and chemical methods.** Zawislanski, P.T. Lawrence Berkeley Lab., CA (USA). Dec 1989. 195p. Sponsored by U.S. DOE Energy Research; U.S. Department of the Interior. DOE Contract AC03-76SF00098. 9-AA-20-07250. Order Number DE90008492. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

Soil and water contamination at Kesterson Reservoir, Merced County, California, by selenium and salts has been an environmental concern for several years. The complex speciation and transport paths of these contaminants in the soil system have been the subject of intense research. The potential for further salt and selenium redistribution in the soil profile due to evaporation, transpiration, and infiltration of water needs to be seriously considered in evaluating the present and future environmental risks. This research project was designed to focus on the process of bare soil evaporation as a likely mechanism for concentrating species at and near the soil surface. To that end, bare soil evaporation rates were measured directly in the field and estimated based on chemical changes in the soil system. The nature of the bare soil evaporation process was examined through empirical and numerical means. Based on changes in near-surface concentrations of salts and selenium over a twelve month period, predictions have been made for likely future changes in species distribution. 120 refs., 110 figs., 11 tabs.

22604 (MAFF-AEMR–21) **Radioactivity in surface and coastal waters of the British Isles, 1988.** Hunt, G.J. Ministry of Agriculture, Fisheries and Food, Lowestoft (UK). Directorate of Fisheries Research. 1989. 69p. Order Number DE90619475. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report presents the results of the aquatic environmental monitoring programme performed during 1988 by the Ministry of Agriculture, Fisheries and Food's (MAFF's) Directorate of Fisheries Research (DFR). Radioactivity measurements are made in aquatic organisms and environmental materials in the vicinity of nuclear establishments including BNFL, UKAEA, nuclear power stations operated by the electricity boards, defence establishments and Amersham International. A summary of estimated public radiation exposures in 1988, relating to liquid radioactive waste discharges from nuclear establishments is presented. (UK).

22605 (OME/WRB–88/3) **Chemical and biological data summary for Lake 222 outflow experiments (experimental lakes area) (May 1983).** Findeis, J.G.; Hall, R.J.; Coleman Taylor, M. Ontario Ministry of the Environment, Dorset, ON (Canada). Water Resources Branch. Nov 1988. 112p. (MICROLOG–90-01030). Available from PC Ontario Business Development Division, Hearst Block, 900 Bay St., Toronto, ON, CAN M7A 2E1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The effects of short-term pH depressions on aquatic biota are poorly documented. This data report presents the physical, chemical, and biological data from an acidification experiment conducted on the outflow of Lake 222 in the Experimental Lakes Area of Northwestern Ontario, an area not normally exposed to such pH depressions. Samples were also collected from a lake outflow that has experienced long-term artificial pH depression (Lake 223) and one that has not been impacted in any way (Lake 224). A detailed description of the methods for the collection of the biotic data is also included.

22606 (ORNL/M–1030) **Mercury monitoring of water and sediment in Oak Ridge National Laboratory streams during 1989.** Taylor, F.G. Jr. Oak Ridge National Lab., TN (USA). Jan 1990. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008080. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An assessment plan was implemented in compliance with the Clean Water Act and the Oak Ridge National Laboratory's (ORNL) National Pollutant Discharge Elimination System (NPDES) Permit to identify, locate, and minimize all sources of mercury contamination in ORNL discharges to the aquatic environment. This plan was designed to identify sources of mercury from past operations and spills through a review of file records and personal interviews. A network of monitoring and sampling stations, based on knowledge of mercury deposits in receiving streams, knowledge of mercury discharges from pipes to streams, and a review of chemical data from previous contaminant surveys, was established for sample collection. The plan was designed to assess the potential for mercury reaching surrounding streams and rivers by placement of sampling sites relative to potential contaminant movement from areas of deposition. This summary report describes the monitoring data for 1989, collected during the first and fourth quarters, while contrasting to the 1988 data. Based on 1988–1989 data, recommendations are proposed to eliminate those sample locations which have not provided quantitative evidence of mercury deposition. Sample locations near sources identified from the monitoring data will be retained in the sample network. 7 refs., 6 figs., 7 tabs.

22607 (ORNL/M–1086) **Biological effects of changes in surface water acid-base chemistry: State-of-Science/Technology report 13.** Baker, J.P.; Bernard, D.P.; Christensen, S.W.; Sale, M.J.; Freda, J.; Heltcher, K.; Rowe, L.; Scanion, P.; Stokes, P.; Suter, G. Oak Ridge National Lab., TN (USA). Jan 1990. 714p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008392. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

This report has three primary objectives. These are to identify chemical variables and characteristics that influence the effects of acidification (and recovery) on aquatic biota, to summarize the effects of changes in surface water acid-base chemistry (acidification and recovery) on biological communities and processes describe procedures to be applied for the National Acid Precipitation Assessment Program (NAPAP) Integrated Assessment for quantifying the relationship between changes in acid-base chemistry and regional effects on fish communities. 990 refs., 172 figs., 100 tabs.

22608 (ORNL/TM–11010) **Particulate matter dynamics and phytoplankton seasonality in a reservoir embayment ecosystem.** Ford, C.J.; Kimmel, B.L.; Olsen, C.R. Oak Ridge National Lab., TN (USA). Dec 1989. 160p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008079. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Phytoplankton losses from the water column and the relationships among seasonal change, algal community structure, and the fate of particle-associated materials were investigated in the Walker Branch embayment of Melton Hill Reservoir, Anderson County Tennessee. Sinking and ascent rates of phytoplankton were measured using settling columns, and in situ particle removal by sinking was estimated using the naturally-occurring radionuclides Beryllium-7 and Lead-210. Changes in autochthonous phytoplankton assemblage composition, concentration and production reflected the seasonal aspects of suspended particle flux. Beryllium-7 removal rates corresponded with those of the predominant form of particulate matter, and differed greatly from removal rates of Lead-210. The rapid associated of particle-reactive materials with the predominant form of particulate matter following input events suggests that the seasonality of particulate matter is a central factor in the sorption, residence time and ultimate fate of particle-associated materials within aquatic ecosystems. 135 refs., 15 figs., 10 tabs.

22609 (PB–90-117045/XAB) **Data compilation to accompany residence times of Minnesota ground waters. Final report.** Alexander, S.C.; Alexander, E.C. Minnesota Univ., Minneapolis, MN (USA). Dept. of Geology and Geophysics. 13 Nov 1989. 54p. (REPT–1123). Available from NTIS, PC A04/MF A01.

Tritium, ^{14}C, and chemical analyses for 80 ground water samples from selected Minnesota aquifers indicate a range of residence times from a few days to tens of thousands of years. Significant nitrate contamination is confined to recent and mixed ground waters. Combined chemical/isotopic studies yield information that will be useful in the design of effective ground water protection plans in Minnesota.

22610 (PB–90-129651/XAB) **Quantity and quality of stormwater runoff recharged to the Floridan aquifer system through two drainage wells in the Orlando, Florida area.** German, E.R. Geological Survey, Reston, VA (USA). Water Resources Div. 1989. 57p. (USGS/WATER-SUPPLY PAPER–2344). Available from NTIS, PC A04/MF A01.

Library of Congress catalog card No. 88-600173.

Quantity and quality of inflow to two drainage wells in the Orlando, Fla., area were determined for the period April 1982 through March 1983. The wells, located at Lake Midget and at Park Lake, are used to control the lake levels during rainy periods. The lakes receive stormwater runoff from mixed residential-commercial areas of about 64 acres (Lake Midget) and 96 acres (Park Lake) and would frequently flood adjacent areas if the wells did not drain the excess stormwater. These lakes and wells are typical of stormwater drainage systems in the area.

22611 (PB–90-130113/XAB) **Ground-water contamination at an inactive coal- and oil-gasification plant site, Gas Works Park, Seattle, Washington. Water-resources investigations.** Turney, G.L.; Goerlitz, D.F. Geological Survey, Denver, CO (USA). Sep 1989. 38p. (USGS/WRI–88-4224). Available from NTIS, PC A03/MF A01.

Gas Works Park, in Seattle, Washington, is located on the site of a coal- and oil-gasification plant that ceased operation in 1956. During operation, many types of wastes, including coal, tar, and oil, accumulated on site. The park soil is presently (1986) contaminated with compounds such as polynuclear aromatic hydrocarbons, volatile organic compounds, trace metals, and cyanide. Analyses of water samples from a network of observation wells in the park indicate that these compounds are also present in the ground water. Polynuclear aromatic hydrocarbons and volatile organic compounds were identified in ground-water samples in concentrations as large as 200 milligrams per liter. Soluble, volatile, low-molecular-weight organic compounds are preferentially dissolved from the nonaqueous phase liquid into the ground water. Concentrations of organic contaminants in the soils may still remain large.

22612 (PB–90-130121/XAB) **Effects of three highway-runoff detention methods on water quality of the surficial aquifer system in central Florida. Water-resources investigations.** Schiffer, D.M. Geological Survey, Reston, VA (USA). Water Resources Div. 1989. 89p. (USGS/WRI–88-4170). Available from NTIS, PC A05/MF A01.

Water quality of the surficial aquifer system was evaluated at one exfiltration pipe, two ponds (detention and retention), and two swales in central Florida, representing three runoff detention methods, to detect any effects from infiltrating highway runoff. Concentrations of major ions, metals, and nutrients were measured in ground water and bottom sediments from 1984 through 1986. At each study area, constituent concentrations in ground water near the structure were compared to concentrations in ground water from an upgradient control site. Analysis of variance of the rank-converted water-quality data at the exfiltration pipe indicated that mean concentrations of 14 of 26 water-quality variables are significantly different among sampling locations (the pipe, unsaturated zone, saturated zone, and the control well). Only phosphorus is significantly higher in ground water near the pipe than in ground water at the control well. Results of the study indicate that natural processes occurring in soils attenuate inorganic constituents in runoff prior to reaching the receiving ground water.

22613 (PB–90-130709/XAB) **Contaminant loading to Puget Sound from two marinas. Puget Sound estuary program. Final report, June 1988-October 1988.** Crecelius, E.A.; Fortman, T.J.; Kiesser, S.L.; Apts, C.W.; Cotter, O.A. Battelle Ocean Sciences, Duxbury, MA (USA). Jul 1989. 67p. Available from NTIS, PC A04/MF A01.

Concentrations of Cu, Pb, Zn, PAH's, TBT and FC bacteria were measured in surface sediment, sediment-trap, and water-column samples at two marinas in Puget Sound during summer of 1988. Levels of contaminants inside the marinas were compared with levels outside. TBT had greatest elevation in marina sediments compared to reference sediments. Few of sediments exceeded Puget Sound AET sediment quality values but most did exceed PSDDA screening levels for in-water disposal of dredged sediment. All marinas estimated to contribute less than one percent of total mass loading of Cu, Pb and Zn to main basin of Puget Sound. Contribution of TBT may be much more significant if antifouling paints are the major source for Puget Sound.

22614 (PB–90-131483/XAB) **Mechanisms for stream corridor protection. Final report.** White, D.C.; Penosky, M.; Braden, J.B.; Mariner, R.D.; Dreher, D. Illinois Univ., Urbana, IL (USA). Aug 1989. 97p. Available from NTIS, PC A05/MF A01.

This report assesses the protection currently provided to stream corridors in Illinois and makes recommendations for improving that protection. In addition to a comprehensive survey of current state and federal activities, the study surveyed selected states in order to identify program or policy alternatives applicable to stream protection in Illinois. These areas included the development of stream classification systems, the involvement of local interests, planning for greenway or stream corridor systems, and educational activities which teach the ecology of streams to the public. These programs offer ideas and suggestions for the state of Illinois to follow in protecting its stream resources. Although Illinois presently has no policy that recognizes the singular values of stream corridors, many of the state activities surveyed took place within the context of a state protection policy.

22615 (PB–90-132648/XAB) **Determination of the toxicity, water-quality interactions, and biomagnification of selenium in aquatic food chains. Technical report for 15 August 1987-14 August 1989 (Final).** Maier, K.J.; Ogle, R.S.; Maier, K.A.R.; Williams, M.J.; Malchow, D. California Univ., Davis, CA (USA). Dept. of Land, Air, and Water Resources. 14 Aug 1989. 128p. Available from NTIS, PC A07/MF A01.

Ecological degradation of aquatic ecosystems associated with the presence of elevated concentrations of the trace element selenium has been of considerable scientific, governmental, and public concern. The increased flux of selenium into several aquatic ecosystems, due to anthropogenic activities, has resulted in death, teratogenesis, reproductive impairment and decreased populations in fish and waterfowl communities in the systems. Research is continuing on several investigations into the toxicity, bioaccumulation, transfer, and biotransformation of selenium in aquatic organisms and laboratory food chains. Initial studies were primarily concerned with the comparative acute and chronic toxicity, water-quality interactions, and toxicological interactions of several chemical species of selenium to a variety of aquatic organisms. Further research

was directed towards the biotransformation, transfer, and subsequent bioaccumulation of selenium in simplified laboratory aquatic food chains. Studies on the transfer, bioaccumulation, and toxicity of selenium from dietary sources to consumers were conducted. The development of methodology for determining and quantifying the biochemical speciation of selenium in aquatic organisms was initiated.

22616 (PB–90-135559/XAB) **Anaerobic dechlorination of 2,4-dichlorophenol in freshwater sediments in the presence of sulfate.** Kohring, G.W.; Zhang, X.; Wiegel, J. Georgia Univ., Athens, GA (USA). c Oct 1989. 5p. Available from NTIS, PC A01/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 10, 2735-2737(Oct 1989). See also PB–89-197495.

In the presence of added sulfate, 2,4-dichlorophenol and 4-chlorophenol were transformed stoichiometrically to 4-chlorophenol and phenol, respectively, in anaerobic freshwater lake sediments between 18 and 40 C. The concomitantly occurring sulfate reduction reduced the initial sulfate concentration from 25 mM to about 6 to 8 mM and depressed methane formation.

22617 (PB–90-136201/XAB) **Health assessment for Woodlands Route 72 Dump, Woodland Township, Burlington County, New Jersey, Region 2. Cerclis No. NJD980505879. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 7p. Available from NTIS, PC A02/MF A01.

The Woodland Route 72 Dump site is on the National Priorities List. The approximately 12-acre site operated during the early 1950s until 1962. Wastes were either buried or burned. The major environmental contamination on-site consists of benzoic acid (64 ppm), dibenzofuran (5.3 ppm), bis(2-ethylhexyl)phthalate (460 ppm), 1,4-dichlorobenzene (3.7 ppm), DDT (1,400 ppm), barium (606 ppm). chromium (1,504 ppm), lead (1,532 ppm), nickel (415 ppm), and mercury (2.3 ppm) in surface waste. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated ground water and soil.

22618 (PB–90-137001/XAB) **Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 14p. Available from NTIS, PC A03/MF A01.

The Beachwood Borough and Berkeley Township National Priorities List Site is located in Ocean County, New Jersey. A portion of the nearby population is exposed to generally low to moderately high levels of lead, copper, and manganese contamination by the ingestion of water. The sources of manganese are still under question and further sampling is required to define these sources. Lead and copper levels are most likely related to the naturally occurring acidic and corrosive ground waters which leach the metals from the household plumbing, and in certain instances, the serving wells. Currently, there appears to be a small segment of the area population that may be exposed to moderately high concentrations of lead in their potable water (0.7 mg/l). Lead contamination of potable water supplies is of public health concern. High concentrations of manganese may have health implications. The manganese concentrations that were found (0.617 mg/l maximum) relate mainly to the aesthetic qualities of the water rather than to public health.

22619 (PB–90-137118/XAB) **Health assessment for Bog Creek Farm Site (BCFS) National Priorities List (NPL) site, Howell Township, Monmouth County, New Jersey, Region 2. CERCLIS No. NJD063157150. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 15p. Available from NTIS, PC A03/MF A01.

The Bog Creek Farm Site, located in a rural area of Howell Township, Monmouth County, New Jersey, is on the National Priorities List. In 1973 and 1974, various wastes were reportedly dumped at the site, including lacquer thinners, paint solvents and resins, disinfectants, animal carcasses, and residential debris. Sampling and analysis of on-site and off-site ground water, surface water, and sediments and of on-site waste and soil revealed several contaminants, primarily volatile organic compounds (VOCs), semi-volatile organic compounds, and heavy metals. Site contamination appears to be greatest immediately adjacent to an on-site waste-disposal trench. A potential public health threat exists from dermal absorption, ingestion, or inhalation of contamination from ground water, surface water, sediment, waste, and soil.

22620 (PB–90-137134/XAB) **Health assessment for Burnt Fly Bog National Priorities List Site, Marlboro, Monmouth County, New Jersey, Region 2. CERCLIS No. NJD980504997. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 24 Aug 1988. 13p. Available from NTIS, PC A03/MF A01.

The Burnt Fly Bog site, a National Priorities List site, is located near Marlboro, Monmouth County, New Jersey in the fringe area of the New Jersey Pine Barrens. The major contaminants at the site are polychlorinated biphenyls (PCBs) and lead. Both of these contaminants have been found in all environmental media at the site. Exposure to contaminants may occur from contact with soil, sediment, water, air, or biota from the site. In order to protect the public health, access to contaminated areas should not be permitted except for properly-protected remedial workers. Because of the potential for ground-water contamination, private well owners surrounding the site should be advised to connect to the public water system. In addition, the consumption of game animals, berries, fish, and other biota from Burnt Fly Bog should be discouraged unless it can be determined that they are free of contamination.

22621 (PB–90-137159/XAB) **Health assessment for Chemical Control Corporation, Elizabeth, New Jersey, Region 2. CERCLIS No. NJD000607481. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Apr 1987. 12p. Available from NTIS, PC A03/MF A01.

The Chemical Control Corporation Site is a National Priority List site located in an industrialized area in Union County. CCS was originally permitted by the State of New Jersey as a special waste facility to engage in reprocessing, reclaiming, recovering, blending, and treating hazardous waste by neutralization, chemical treatment, or incineration. The site has had a long history of violations and was closed as of March 1979. Subsurface soil and groundwater are contaminated with inorganic and organic chemicals. The volatile organic compounds appear consistently throughout the site. Ground-water results correlate well with the results of subsurface soil with the most contaminated ground-water samples collected from areas having extensive subsurface soil contamination. On-site contaminants have migrated off-site and have contributed somewhat to the contamination of the Elizabeth River.

22622 (PB–90-137167/XAB) **Health assessment for Chemical Leaman Tank Lines, Inc. (CLTL) NPL (National Oriorities List) site, Logan Township, Gloucester County, New Jersey, Region 2. CERCLIS No. NJD047321443. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 17p. Available from NTIS, PC A03/MF A01.

The Chemical Leaman Tank Lines, Inc. (CLTL) Site is a National Priorities List Site located in Logan Township, Gloucester County, New Jersey. CLTL is a common carrier of bulk chemical commodities, some of which are hazardous. CLTL previously used several rinse-water settling ponds and aeration lagoons as part of the cleaning and washing process for tank trailers. These ponds and lagoons have been removed; however, contamination from them has entered the underlying groundwater. On-site workers may be exposed to VOCs that are released to the ambient air from the on-site production well and from tank washing operations. Human exposure to on-site contaminants may also occur by inhalation and ingestion of contaminated subsurface soil particulates and dust during remedial or construction activities.

22623 (PB–90-137175/XAB) **Health assessment for Chemsol Inc., Piscataway, Middlesex County, New Jersey, Region 2. CERCLIS No. NJD980528889. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Chemsol Inc. Site is on the National Priorities List. The inactive 12-acre site is located in Piscataway (Middlesex County), New

Jersey. EPA suspects that 40 drums of chemical waste are buried on-site. Access to the site is restricted. Removal actions have not occurred. Preliminary on-site sampling results have identified various volatile organic compounds. They include chloroform, tetrachloroethylene, trichloroethylene, carbon tetrachloride, toluene, and benzene. Neither the sampling results nor the environmental media where the contaminants were found were reported. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

22624 (PB–90-137183/XAB) **Health assessment for Ciba-Geigy National Priorities List (NPL) site, Dover Township, Ocean County, New Jersey, Region 2. CERCLIS No. NJD00150217. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Oct 1988. 35p. Available from NTIS, PC A03/MF A01.

The Ciba-Geigy site is a National Priorities List site located in a heavily populated area of Dover Township, New Jersey, and is surrounded by a number of adjoining residential communities. Because of a diversity of past and present production and disposal operations, the site includes numerous on-site contaminant sources. Site contaminants consist of a variety of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated hydrocarbon insecticides, and heavy metals. Site contaminants have been identified in on-site surface soil and ground water, and in off-site sediment, surface water, ground water (including private residential wells), and air. The site is of public health concern because of the risk to human health caused by probable human exposure to hazardous substances at levels that may result in adverse human health effects over time.

22625 (PB–90-137191/XAB) **Health assessment for Combe Fill North Landfill, Mount Olive Township, New Jersey, Region 2. CERCLIS No. NJD980530596. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). May 1988. 10p. Available from NTIS, PC A02/MF A01.

The Combe Fill North Landfill National Priorities List Site is located in Mount Olive Township, Morris County, New Jersey. Volatile organic compound and heavy metal contamination was present in the soil, sediment, surface water, and ground water. The Record of Decision provides for a cap, a drainage system, a methane venting system, a fence around the site perimeter, and a monitoring program to ensure the effectiveness of the remedial action. The remedial action should be protective of public health once complete; in the interim, site access should be restricted to help prevent exposure to site contaminants.

22626 (PB–90-137209/XAB) **Health assessment for Combe Fill South Landfill, Morris County, New Jersey, Region 2. CERCLIS No. NJD094966611. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). May 1988. 14p. Available from NTIS, PC A03/MF A01.

The Combe Fill South Landfill National Priorities List Site is located on the township boundary between Chester and Washington Townships in Morris County, New Jersey. Until the remedial activities are complete, there is a potential public health threat from inhalation of gases produced within the waste pile, consumption of trout from Trout Brook, incidental ingestion and/or dermal absorption of surface water, dermal absorption and ingestion of ground water used in homes, and inhalation of volatile organic chemicals (VOCs) volatilized from contaminated ground water during household used.

22627 (PB–90-137233/XAB) **Health assessment for CPS/Madison Industries, Old Bridge Township, Middlesex County, New Jersey, Region 2. CERCLIS No. NJD002141190. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The CPS/Madison Industries site is on the National Priorities List. CPS processes, treats, and stores organic chemicals and Madison Industries produces zinc compounds for fertilizers, pharmaceuticals, and food additives. The environmental contamination on-site consists of the following: methylene chloride, 1,1-dichloroethane, trans-1,2-dichloroethylene, 1,2-dichloroethane, trichloroethylene, benzene, chlorobenzene, toluene, cadmium, and lead in ground water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated ground water, surface water, sediment, and airborne particulate.

22628 (PB–90-137241/XAB) **Health assessment for Curcio Scrap Metal Yard, Saddle Brook Township, Bergen County, New Jersey, Region 2. CERCLIS No. NJD011717584. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jul 1988. 8p. Available from NTIS, PC A02/MF A01.

The Curcio Scrap Metal Yard is on the National Priorities List. The facility is an active scrap metal yard, which over a three-month period, purchased and scrapped 50 transformers, releasing polychlorinated biphenyls (PCBs) on-site. The predominant contaminants of concern are the polychlorinated biphenyls (PCBs), arachlor 1260, and arachlor 1248. EPA and the New Jersey Department of Environmental Protection have conducted only limited sampling to date. Contaminated or potentially contaminated environmental pathways associated with the site appear to be on-site and off-site soil, groundwater, and surface water, with further potential for food-chain contamination if the contaminants (PCBs) have reached nearby Schroeders Brook and accumulated in aquatic species used for human consumption. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via the above-named human-exposure pathways.

22629 (PB–90-137258/XAB) **Health assessment for D'Imperio Property Site, Hamilton Township, New Jersey, Region 2. CERCLIS No. NJD980529416. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Aug 1988. 11p. Available from NTIS, PC A03/MF A01.

The D'Imperio Property Site is an inactive National Priorities List waste disposal site consisting of two disposal areas, Sites 1 and 2. Site 1 consists mainly of partially buried metal drums, most of which have ruptured. Site 2 consists mainly of domestic refuse. The drums in Site 1 contained primarily various organic compounds, including solvents, which have contaminated the soil and ground water at the site. The available data indicated the residential wells were not contaminated by compounds from the site. However, more current data are needed to evaluate the present exposure potential.

22630 (PB–90-137266/XAB) **Health assessment for Derewal Chemical Company National Priorities List (NPL) site, Kingwood Township, Hunterdon County, New Jersey, Region 2. CERCLIS No. NJD980761373. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 15p. Available from NTIS, PC A03/MF A01.

The site is listed on the National Priorities List. The site (including Pinkerton Dump) is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to lead and sodium (which may not be site-related) may occur, may be occurring, and may have occurred via ingestion of residential well water. Human exposure to lead in on-site surface soils may occur, may be occurring, or may have occurred via oral (ingestion) and inhalation exposure to soils and soil dusts.

22631 (PB–90-137274/XAB) **Health assessment for Diamond Alkali/80 Lister Avenue, Newark, New Jersey, Region 2. CERCLIS No. NJD980528996. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Nov 1987. 19p. Available from NTIS, PC A03/MF A01.

The 3.4-acre site is located in the Ironbound Section in Newark, New Jersey. The major contaminant of concern is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Other contaminants of concern present on-site include benzene, chlorobenzene isomers, trichlorophenols, and DDT. On-site, and possibly off-site, soil TCDD concentrations pose a significant public health threat to workers involved in remedial site activities (and possibly nearby workers and area residents) and direct contact should not occur. Ground water beneath the site poses a potential public health

threat to users; use of the ground water for drinking, bathing, showering, washing, and cooking should not be permitted.

22632 (PB–90-137282/XAB) **Health assessment for Evor Phillips Leasing, Old Bridge Township, Middlesex County, New Jersey, Region 2. CERCLIS No. NJD980654222. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Evor Phillips Leasing (EPL) Site is on the National Priorities List. EPL has been reported to contain between 4,000 and 5,000 drums containing chemical wastes. Preliminary on-site sampling results have identified 1,2-dichloroethane (570 ppm in soil, 10 ppm in ground water, 4 ppm in private well), and trichloroethylene (197 ppm in soil, 358 ppb in ground water). Other substances identified in on-site soils include: ethylbenzene (1,590 ppm), toluene (3,240 ppm), phthalates (8 ppm in test pit waste). In addition, copper (200 ppb), nickel (69 ppb), and zinc (2,400 ppb) were detected in a private well. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances via ground water, soil, leachate, sediment, and surface water.

22633 (PB–90-137290/XAB) **Health assessment for Fairlawn Wellfield, Fairlawn, New Jersey, Region 2. CERCLIS No. NJD980654107. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Fairlawn Wellfield Site is on the National Priorities List. In 1978, volatile organic compounds were detected in four municipal supply wells located within and adjacent to the Fairlawn Industrial Park. The environmental contamination on-site (maximum concentrations reported) consists of benzene (250 ppm), ethylbenzene (230 ppm), trichloroethylene (1,000 ppm), and toluene (670 ppm) in soil; and methylene chloride (3 ppm), tetrachloroethylene (2 ppm), benzene (25 ppm), trichloroethylene (50 ppm), and 1,1,1-trichloroethane (2 ppm) in ground water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ground water, surface water, and soil.

22634 (PB–90-137357/XAB) **Health assessment for Fort Dix Sanitary Landfill, Pemberton Township, New Jersey, Region 2. CERCLIS No. NJ2210020275. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Dec 1988. 10p. Available from NTIS, PC A02/MF A01.

The 113-acre Fort Dix Sanitary Landfill is located in the southwest section of the U.S. Army Fort Dix Military Reservation near Pemberton Township, Burlington County, New Jersey. The Fort Dix Sanitary Landfill was in operation from 1950 until official closing on July 6, 1984. Soil, sediment, surface water, air, and groundwater samples were taken. Analyses of these samples show no contamination of public health concern in the air or soil at the landfill. Sediment and surface-water samples taken show no contamination of public health concern. No contaminants of public health concern were shown in the swamp sediment. No subsurface soil samples were taken in the landfill because of the explosive hazard associated with that type of operation at this site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ingestion of surface water, biota, and ground water, and inhalation or direct dermal contact with surface water and ground water.

22635 (PB–90-137373/XAB) **Health assessment for Goose Farm National Priorities List (NPL) site, Plumsted Township, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980530109. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Goose Farm National Priorities List Site is located in Plumsted Township, Ocean County, New Jersey. Both solid and liquid wastes in bulk, 55-gallon drums, 5-gallon pails, and lab packs were disposed at the site in a 15-foot deep pit from the mid-1940s to the mid-1970s. On-site and off-site media are contaminated with a variety of volatile organic compounds (VOCs), heavy metals, polychlorinated biphenyls, acid/base neutral compounds, and semi-volatile compounds. Environmental media that have been contaminated are surface water, ground water, and subsurface soils. On-site soil, contaminated with PCBs above 5 parts per million, is currently being excavated and disposed in an approved off-site facility. The selected remedial alternative should reduce the potential for further off-site migration of contaminants. Over time, the remediation should mitigate the contamination at the Goose Farm Site, thus protecting the health of the human population in the area.

22636 (PB–90-137399/XAB) **Health assessment for Hercules Inc., Gibbstown, Glocester County, New Jersey, Region 2. CERCLIS No. NJD002349058. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Hercules Inc. is on the National Priorities List. The company disposed of solvents, acids, and waste oils in two unlined disposal pits. Preliminary on-site ground-water sampling results have identified benzene (1.4 ppm), phenol (40 ppm), and isopropyl benzene (18 ppm). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Further investigation is warranted.

22637 (PB–90-137415/XAB) **Health assessment for Kin-Buc Landfill, Edison Township, New Jersey, Region 2. CERCLIS No. NJD049860836. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 3 Jun 1987. 13p. Available from NTIS, PC A03/MF A01.

Kin-Buc Landfill, Edison Township, New Jersey, Received municipal and industrial wastes for 20 years. More than 100 toxic contaminants have been identified in the ground water, surface water, sediment, and air, with major pathways of release being ground water and surface transport of leachate, and volatilization into the air. The assessment appears to be based on data from many sources and the quality of the data cannot be verified.

22638 (PB–90-137423/XAB) **Health assessment for Lang Property National Priorities List (NPL) site, Pemberton Township, Burlington County, New Jersey, Region 2. CERCLIS No. NJD980505382. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 26p. Available from NTIS, PC A03/MF A01.

The Lang Property National Priorities List Site is located in Pemberton Township, Burlington County, New Jersey. Unauthorized disposal of hazardous wastes occurred on approximately two acres of the 40-acre site. The contaminant classes that were identified on the site are volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and metals. The contaminant classes of concern are PCBs, VOCs, and semi-VOCs for on-site ground water. VOCs is the contaminant class of concern for sediments and surface water. The on-site ground water is highly contaminated; at the maximum chemical concentrations detected, use of this water without treatment would pose a human health concern. The potential does exist for human exposure to ground water contaminants by ingestion, inhalation of volatilized VOCs from ground water, and dermal absorption. The surface soils are also highly contaminated and represent a current possible as well as future human health concern for trespassers, blueberry farm workers and harvesters, and construction and remedial workers.

22639 (PB–90-137449/XAB) **Health assessment for Lone Pine Landfill National Priorities List (NPL) site, Freehold, Monmouth County, New Jersey, Region 2. CERCLIS No. NJD980505424. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Apr 1989. 23p. Available from NTIS, PC A03/MF A01.

The Lone Pine Landfill National Priorities List site is in Monmouth County, New Jersey. The facility operated from 1959 to 1979 and received chemical, municipal, and septage wastes. The principal contaminants determined by monitoring are volatile organic compounds and metals. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Contaminants, principally volatile organic compounds, have been detected at levels of potential concern in

ground water on-site and immediately off-site, in soils on-site, in the air at the site perimeter under certain atmospheric conditions, and in surface water in the river. Ground water is the principal medium of concern because it is the source of potable water in the area. Surface water is also of concern because of the water-supply reservoir that will draw water from the river downstream.

22640 (PB–90-137456/XAB) **Health assessment for Matlack, Incorporated, Swedesboro, Gloucester County, New Jersey, Region 2. CERCLIS No. NJD043584101. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Matlack, Incorporated site, on the National Priorities List, is a tank cleaning and truck terminal that has been in operation since 1960. The environmental contamination on-site consists of total volatile organic hydrocarbons in ground water (11 ppb) and soil, including chloroform, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, xylenes, toluene, benzene, chlorinated benzenes, and methylene chloride. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater.

22641 (PB–90-137464/XAB) **Health assessment for Mannheim Avenue Dump, Galloway Township, New Jersey, Region 2. CERCLIS No. NJD980654180. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Mannheim Avenue Dump site is on the National Priorities List. The two-acres site was used by Galloway Township and a local industry, Lenox China, for waste disposal during the 1960s and 1970s. On-site environmental contamination consists of lead (48,000 ppm), chromium (28 ppm), and non-specific petroleum hydrocarbons (530 ppm) in soil, and trichloroethylene (140 ppb), and zinc (51 ppb) in ground water monitoring wells. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility to exposure to hazardous substances via migration of hazardous substances into ground water used for water supplies.

22642 (PB–90-137480/XAB) **Health assessment for Monroe Township Landfill, Monroe, New Jersey, Region 2. CERCLIS No. NJD980505671. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Monroe Township Landfill is on the National Priorities List. The 86-acre site is located in Monroe (Middlesex County), New Jersey. Preliminary on-site leachate sample results have identified various volatile organic compounds. They include toluene, vinyl chloride, 1,2-dichlorobenzene, and 1,4-dichlorobenzene. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances via direct contact.

22643 (PB–90-137498/XAB) **Health assessment for Montgomery Township Housing Development, Montgomery, New Jersey, Region 2. CERCLIS No. NJD980654164. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Jul 1988. 13p. Available from NTIS, PC A03/MF A01.

The Montgomery Township Housing Development National Priorities List site is located on approximately 72 acres in Somerset County, New Jersey. In 1979 samples from private wells were taken and shown to be contaminated with high levels of trichloroethene (TCE) as well as other contaminants. Presently, the primary contaminants of concern are TCE and lead present in the private wells of the homes in the housing development. An emergency response action was requested to provide an interim alternate water source to those residences that warranted it.

22644 (PB–90-137514/XAB) **Health assessment for Nascolite Corporation, Millville, New Jersey, Region 2. CERCLIS No. NJD002362705. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 3 Jun 1987. 14p. Available from NTIS, PC A03/MF A01.

The Nascolite Site (NS) is an NPL site located in Millville (Cumberland County), in southern New Jersey. Methyl methacrylate and various other plasticizers have been identified. The volatile organic compounds (VOCs) identified on-site include benzene, toluene, ethylbenzene, xylene, cumene, n-propyl benzene, trimethylbenzene, n-butyl benzene, cyclopropyl benzene, trichloroethane, styrene, hexachlorobutadiene, 1,2-dichloroethane, 0-dichlorobenzene, naphthalene, trichloroethylene, sec-butyl benzene, 2,3-benzofuran, methylene chloride, 1,2-dichloropropane, and some 8 to 17 unidentified chemicals. NS is contaminated with significant concentrations of methyl methacrylate, other plasticizers, and VOCs, and represents a potential public health hazard to area residents and on-site workers during remedial efforts. In addition, significant gross alpha radiation has been detected.

22645 (PB–90-137522/XAB) **Health assessment for Naval Air Engineering Center, Lakehurst, Ocean County, New Jersey, Region 2. CERCLIS No. NJ7170023744. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The Naval Air Engineering Center site is on the National Priorities List. On-site environmental contamination consists of lead, 1,1-dichloroethane, and trans-1,2-dichloroethylene in non-potable water wells; arsenic, lead, xylene, trichloroethylene, ethylbenzene, trimethyl benzene, and methylethyl benzene in ground water; zinc in surface water; fluoranthene, pyrene, and 1,2,4-trichlorobenzene in soil; and heavy metals in stream sediment. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated ground water, soil, sediment, and surface water.

22646 (PB–90-137530/XAB) **Health assessment for Naval Weapons Station-Site A, Colts Neck, New Jersey, Region 2. CERCLIS No. NJ0170022172. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Naval Weapons Station site is listed on the National Priorities List. The site is an active Naval facility which handles, stores, renovates, and ships munitions. The environmental contamination consists of lead, zinc, and titanium. There are not enough data and information to evaluate the site for its public health implications. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

22647 (PB–90-137548/XAB) **Health assessment for N.L. Industries, Inc., Pedricktown, New Jersey, Region 2. CERCLIS No. NJD061843249. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The N.L. Industries, Inc. Site (NLI) is on the National Priorities List. The 46-acre site is located in Pedricktown (Salem County), New Jersey. The site is a former secondary lead smelting facility which operated from 1972 to 1984. In addition, a closed landfill exists on-site that contains process wastes (slag and rubber materials) from the plant and lead contaminated soils that were excavated from the facility grounds. Preliminary on-site sampling results have identified lead (36 to 83,600 ppm in soil, 7.5 ppm in surface water, 0.01 to 11 ppm in ground water). In addition, arsenic and cadmium was identified along with selenium (1 ppm) in on-site ground water. Arsenic and cadmium were reported to be at concentrations that exceed standards. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact and incidental ingestion of contaminated soil and surface water by area residents is the most likely route of exposure.

22648 (PB–90-137571/XAB) **Health assessment for PJP Landfill, Judson County, Jersey City, New Jersey, Region 2. CERCLIS No. NJD980505648. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Oct 1988. 8p. Available from NTIS, PC A02/MF A01.

The PJP Landfill site is listed on the National Priorities List. The approximately 87-acre site may have been used since 1968 to dispose of an unknown quantity of chemical and industrial wastes. The State certified the landfill to receive hazardous wastes in 1971. The site presently is closed. On-site environmental contamination

consists of chromium (40 ppb), phenols (33,000 ppb), various pesticides (up to 7,000 ppb), and volatile organics (up to 9,000 ppb) in ground water; and benzene (27 ppb), chlorobenzene (33 ppb), and lead (500 ppb) in leachate in the ditch. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated surface water.

22649 (PB–90-137597/XAB) **Health assessment for Renora Site, Edison Township (bonhantown), New Jersey, Region 2. CERCLIS No. NJD070415005. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

Renora Incorporated, an approximately 1-acre site on the National Priorities List, began operations in 1978 as a licensed collector/hauler of waste oil and operated until 1982. During this time, Renora also transported and accepted hazardous substances for transfer, storage, and blending. On-site surficial soils were contaminated with polychlorinated biphenyls, polynuclear aromatic hydrocarbons, and lesser quantities of volatile organic compounds (VOCs) and metals. The shallow groundwater was contaminated with chloroethane and metals. The surface water and sediments were contaminated with metals and VOCs. The site is of public health concern because there is potential for exposure to hazardous substances at concentrations of health concern.

22650 (PB–90-137605/XAB) **Health assessment for Ringwood Mines/Landfill National Priorities List (NPL) site, Ringwood, Passaic County, New Jersey, Region 2. CERCLIS No. NJD980529739. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Apr 1989. 14p. Available from NTIS, PC A03/MF A01.

The Ringwood Mines/Landfill located in Ringwood, Passaic County, New Jersey is on the National Priorities List. Magnetite mines were operated on the site as early as the 1700s and disposal of wastes at the site has occurred since the 1960s. Municipal refuse and industrial wastes were deposited in an on-site landfill. The primary contaminants found at the site are arsenic, cadmium, lead, and methylene chloride. The site poses a potential public health concern because of the risk to human health that could result from possible exposure to hazardous substances via contaminated soils and ground water.

22651 (PB–90-137613/XAB) **Health assessment for Rockaway Borough Well Field National Priorities List (NPL) site, Borough of Rockaway, Morris County, New Jersey, Region 2. CERCLIS No. NJD980654115. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 15p. Available from NTIS, PC A03/MF A01.

The Rockaway Borough Well Field is a National Priorities List site located in the Borough of Rockaway, Morris County, New Jersey. Because of yet unidentified source(s) of trichloroethylene (TCE) and tetrachloroethylene (PCE) in ground water, municipal wells of the Borough of Rockaway have been contaminated sometime prior to 1980, when well water was found to contain high concentrations of these volatile organic compounds. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to elevated concentrations of TCE and/or PCE may occur, be occurring, or have occurred via oral, dermal, or inhalation exposure to contaminated municipal drinking water (only in the unlikely event that breakthrough occurs) or private well water.

22652 (PB–90-137621/XAB) **Health assessment for Rocky Hill Municipal Wellfield, Rocky Hill, New Jersey, Region 2. CERCLIS No. NJD980654156. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Aug 1988. 15p. Available from NTIS, PC A03/MF A01.

The Rocy Hill Municipal Wellfield (RHMW) National Priorities List site is located in Somerset County, New Jersey. In 1979 samples from the RHMW wells were shown to be contaminated with high levels of trichloroethene (TCE) as well as other volatile organic compounds (VOCs). Presently, the municipal well which is still in operation (Well 2) is provided with an air-stripping unit, installed in 1983. The Record of Decision for the second operable unit (i.e., ground water treatment) selected a remedy that includes: extraction of ground water from the surficial aquifer, provision of municipal water to the remaining private well users, sealing of abandoned private wells, and provision of a ground water monitoring system. The remedy should be adequate to address exposure to ground water contamination; however, exposure of area residents to airborne VOCs, volatilizing from contaminated soil or ground water, is still a potential health concern at the site.

22653 (PB–90-137639/XAB) **Health assessment for Sayreville Landfill, Middlesex County, Sayreville, New Jersey, Region 2. CERCLIS No. NJD980505754. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Oct 1988. 8p. Available from NTIS, PC A02/MF A01.

The Sayreville Landfill site is on the National Priorities List. The Sayreville Landfill was licensed to receive municipal waste and light industrial waste; however, allegedly, hazardous waste also was disposed of during operations and after closure in 1977. On-site contamination consists of pentachlorophenol and p-ethyl toluene (concentration not reported), in drums which were removed from the site in 1982; benzene (110 ppb), toluene (105 ppb), arsenic (11,500 ppb) and chloroform (87 ppb) in soil; iron (596,000 ppb), manganese (2,700 ppb), phenol (2,300 ppb), 2-methyl phenol (3,100 ppb), and benzene (200 ppb) in ground water. The site is considered to be of potential public health concern because of the possibility of exposure to hazardous substances via surface water (and ingestion of contaminated aquatic organisms) and possibly ground water.

22654 (PB–90-137654/XAB) **Health assessment for Sharkey Landfill, Troy Hills, New Jersey, Region 2. CERCLIS No. NJD980505762. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Dec 1988. 13p. Available from NTIS, PC A03/MF A01.

The Sharkey Landfill is a National Priorities List site located in the Townships of Parsippany-Troy Hills and East Hanover, Morris County, New Jersey. The total landfill area is approximately 90 acres and is divided into 4 separate sections. The landfill began operation in 1945 accepting municipal wastes from several surrounding counties and some hazardous and/or toxic materials. Records indicated these materials included approximately 100,000 gallons of various volatile organic compounds (VOCs). The landfill also accepted wastes from sewage treatment plants. Data from monitoring wells on-site indicated the ground water in the shallow aquifer is contaminated with VOCs and metals at concentrations above the drinking-water standards. Sharkey Landfill is of potential health concern because there is potential for contaminant migration off-site in ground water and surface water.

22655 (PB–90-137662/XAB) **Health assessment for Shieldalloy Corporation, Newfield Borough, Gloucester County, New Jersey, Region 2. CERCLIS No. NJD002365930. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Shieldalloy Corporation site is on the National Priorities List. The approximately 62-acre site is an active specialty plant making chromium alloy products. Past disposal practices have resulted in extensive chromium contamination of the ground water. On-site contamination consists of hexavalent chromium (55 ppm) in ground water; and chromium in sludge (20%). Off-site contamination consists of hexavalent chromium in ground water (33 ppm) and surface water (35 ppm), and trichloroethylene (3 ppm) in surface water. The trichloroethylene may not be site related. Low-level radioactive wastes have been reported to be on-site, but no supporting documentation was presented. The Company is licensed by the Nuclear Regulatory Commission. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ground water, surface water, soils, sludges, airborne particulate, and ingestion of contaminated fish.

22656 (PB–90-137712/XAB) **Health assessment for Tabernacle Drum Dump National Priorities List (NPL) site, Tabernacle Township, Burlington County, New Jersey, Region 2. CERCLIS No. NJD980761357. Final report.** Agency for Toxic

Substances and Disease Registry, Atlanta, GA (USA). 26 Oct 1988. 20p. Available from NTIS, PC A03/MF A01.

The Tabernacle Drum Dump NPL Site is located in Burlington County, New Jersey. The site groundwater is contaminated with volatile organic compounds (VOCs), primarily 1,1,1-trichloroethane (TCA) and inorganic chemicals, primarily lead, cadmium, and chromium. Levels of 1,1-dichloroethene (DCE) were found in two monitoring wells. The site surface soils are primarily contaminated with chromium, lead and cyanide. The Tabernacle Drum Dump site poses a potential public health threat. If the site remains unremediated, the levels of TCA, DCE, cadmium, chromium, and lead found in the on-site groundwater may further increase the contamination of residential wells. Populations at risk of exposure are trespassers, children that play on the site, construction and remedial workers, and nearby residents.

22657 (PB–90-137787/XAB) **Health assessment for Woodland Route 532 Dump, Woodland Township, Burlington County, New Jersey, Region 2. CERCLIS No. NJD980505887. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Woodland Route 532 Dump site is on the National Priorities List. The 35-acre facility was used by several chemical manufacturers in the 1950s and early 1960s for open burning, dumping, and burial of drummed chemical wastes. On-site contamination consists of pentachlorophenol (182 ppb) in ground water. Although air sampling has not been conducted, it was reported that levels of chemicals in the air were judged by investigators to pose a respiratory hazard during site-invasive sampling procedures. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contact with surface materials on-site.

22658 (PB–90-138751/XAB) **Health assessment for Islip Sanitary Landfill, Suffolk County, New York, Region 2. CERCLIS No. NYD980506901. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Jun 1988. 8p. Available from NTIS, PC A02/MF A01.

The Islip Sanitary landfill 40-acre site has been in operation since 1927, accepting municipal and industrial wastes. The site continues to operate. The site is unlined, and only partially capped. Environmental sampling conducted to date indicates that the contaminants of immediate concern are predominately volatile organic chemicals (VOCs) in ground water and perhaps air. The VOCs present in one or more environmental media include trichloroethylene (TCE); tetrachloroethylene (perchloroethylene (PCE)); trichloroethane (TCA); vinyl chloride; and methylene chloride. Contaminated or potentially contaminated environmental pathways associated with the site which are of greatest public health importance are on-site and off-site ground water, and possibly air. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances. While it does not appear that a human population is currently exposed to site contaminants, the potential for such exposure remains and should be carefully monitored.

22659 (PB–90-138769/XAB) **Health assessment for Hudson River PCB (polychlorinated biphenyl) NPL (National Priorities List) site, State of New York, Region 2. CERCLIS No. NYD980763841. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 20p. Available from NTIS, PC A03/MF A01.

Hudson River PCB (polychlorinated biphenyls) is a National Priorities List site located in the State of New York. Because of the past disposal of PCBs in the Hudson River, surface water, sediment, and fish from the Upper and Lower Hudson River are contaminated with elevated concentrations of PCBs. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to PCB-contaminated fish or other consumable aquatic organisms from the Hudson River may occur and/or may be occurring via oral exposure (ingestion). Possible inhalation of volatilized PCBs, airborne PCB-contaminated dusts, as well as dermal contact with PCB-contaminated sediment are also of potential concern to human health.

22660 (PB–90-138793/XAB) **Health assessment for Hyde Park Landfill National Priorities List (NPL) site, Niagara Falls, New York, Region 2. CERCLIS No. NYD000831644. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Feb 1989. 19p. Available from NTIS, PC A03/MF A01.

The Hyde Park Landfill National Priorities List Site was used by Hooker Chemical and Plastic Corporation, now Occidental Chemical Corporation, to dispose of approximately 80,000 tons of waste from 1953 to 1975. Significant amounts of 2,3,7,8-tetrachlorodibenzo-p-dioxin is believed to be in the landfill. Site-related contaminants have been detected in the overburden and bedrock aquifers. Analyses of samples taken from ground water seeps at the Niagara Gorge Face also show site-related contaminants. Leachate from the landfill appears to have entered Bloody Run Creek. Sediment sample analyses from the creek show site-related contaminants. The 1985 U.S. Environmental Protection Agency Enforcement Decision Document outlines remedial activities to be conducted at the site. The site without remediation is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

22661 (PB–90-138801/XAB) **Health assessment for Hooker Chemical (102nd Street Landfill), Niagara Falls, New York, Region 2. CERCLIS No. NYD980506810. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 10p. Available from NTIS, PC A02/MF A01.

The 102nd Street Landfill is two sites that comprise 22 acres. Occidental Chemical Corporation (OCC) and its predecessor, the Oldbury Electrochemical Company, deposited approximately 23,500 tons of mixed organic solvents, organic and inorganic phosphates, and related chemicals. Included in the site are approximately 300 tons of hexachlorocyclohexane process cake, including lindane. In addition, brine sludge, fly ash, electrochemical cell parts and related equipment in unknown quantities were dumped at the site. On-site contamination of the 102nd Street Landfill includes soils contaminated with non-aqueous phase liquids on both portions of the Landfill. Off-site contamination, based on current studies, results from contaminated ground-water leaching into the Niagara River which causes contamination of the river water, sediments, and aquatic organisms, including fish. The 102nd Street Landfill continues to represent a potential public health threat.

22662 (PB–90-138819/XAB) **Health assessment for Hertel Landfill Inc., Ulster County, Plattekill, New York, Region 2. CERCLIS No. NYD980780779. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

Environmental Landfills Incorporated, formerly the Hertel Landfill Site, is on the National Priorities List. The site operated between 1963 and 1977 as a landfill receiving both residential and industrial wastes. Only limited sampling has been conducted on-site. Contaminants found in monitoring wells at the site include methylene chloride, trichloroethylene, 1,1-dichloroethane, and elevated levels of metals. Private residential wells downgradient of the site have been confirmed to contain 1,1,1-trichloroethane and benzene. Based on the available information, the site poses a potential public health threat to adjacent residences and potential human exposure to people on and in the vicinity of the site.

22663 (PB–90-138827/XAB) **Health assessment for Haviland Complex National Priorities List (NPL) site, Hyde Park, New York, Region 2. CERCLIS No. NYD980785661. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 22 Aug 1988. 19p. Available from NTIS, PC A03/MF A01.

The Haviland Complex National Priorities List site is located near Hyde Park, New York. Discharges from septic leach fields have contaminated the local ground water with dichlorobenzene, tetrachloroethylene, trichloroethylene, trans-1,2-dichloroethylene, and vinyl chloride. The local groundwater was used for drinking water by the on-site population from the late 1960s through 1983. It is believed that the residences with affected wells have used bottled

or treated water for potable purposes since 1983 and continue to use the ground water for sanitation purposes. The Haviland site poses a threat to public health as a result of the direct ingestion, dermal contact, and inhalation of the contaminants in the ground water. The Record of Decision signed on September 30, 1987 requires that the aquifer be restored to drinking water quality, the affected and potentially affected residents be connected to the Harbourd Hills water distribution system, and the local septic disposal systems be cleaned.

22664 (PB–90-138835/XAB) **Health assessment for Griffiss Air Force Base NPL (National Priorities List) site, Rome, Oneida County, New York, Region 2. CERCLIS No. NY4571924451. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 9 Jun 1988. 21p. Available from NTIS, PC A03/MF A01.

The Griffiss Air Force Base National Priorities List Site is located near the City of Rome, New York. Most of these sites have not been sufficiently investigated at this time for a complete determination of their possible health effects. Residential wells south of Griffiss Air Force Base are contaminated with volatile organic compounds: trichloroethene and 1,1,2,2-tetrachloroethane. The measured concentrations of trichloroethene and 1,1,2,2-tetrachloroethane, to date, are below levels of concern. The site is of potential public health concern because of the risk to human health that could result from possible future exposure to hazardous substances at levels that may result in adverse health effects over time.

22665 (PB–90-138843/XAB) **Health assessment for Goldisc Recording, Holbrook, New York, Region 2. CERCLIS No. NYD980768717. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1988. 13p. Available from NTIS, PC A03/MF A01.

Goldisc Recording is listed on the National Priorities List. Dichloroethanes, 1,1,1,1-trichloroethane, di-n-butyl phthalate, tetrachloroethylene, trichloroethylene, chromium, and lead are the contaminants of concern in the on-site monitoring wells. The site represents a potential public health threat. Workers on-site are potentially exposed to contaminated surficial soils. Monitoring of public water supplies and identification of private water supplies are needed to ensure safe drinking water for area residents.

22666 (PB–90-138850/XAB) **Health assessment for Genzale Plating, Franklin Square, New York, Region 2. CERCLIS No. NYD002050110. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 10p. Available from NTIS, PC A02/MF A01.

The Genzale Plating Site is located in Franklin Square, Nassau County. Prior to 1981, process waste waters containing high concentrations of heavy metals and possibly some solvents were discharged into several leaching pits behind the facility. Limited cleanup of surficial contaminants (soils/sludge removal) has been performed. Environmental sampling at the site has been limited to inorganic analyses of the leachate pits and ground water. The waste water is contaminated by high concentrations of several metals, most notably nickel at 680 mg/L and chromium(+6) at 51 mg/L. Contaminated or potentially contaminated environmental pathways associated with this site are on-site soil, sludge and waste water, on-site and off-site ground water. If volatile organic chemicals are present at the site, both air and soil gas could represent pathways for environmental contamination. The site represents a potential public health threat. Analysis of soils and ground water on-site for volatile organic chemicals is necessary. Routine monitoring of public water-supply wells will reveal any impacts from the site. Any private wells still in use should be located and tested.

22667 (PB–90-138868/XAB) **Health assessment for General Motors Central Foundry, St. Lawrence County, Massena, New York, Region 2. CERCLIS No. NYD091972554. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 16p. Available from NTIS, PC A03/MF A01.

The General Motors Central Foundry Division is an aluminum casting plant on 270 acres located on the south bank of the St. Lawrence River in Massena, New York. The plant has been in operation since 1959. Polychlorinated biphenyls (PCBs) were used in the hydraulic fluids for die-casting machines from 1968-1973. Sludges containing PCBs were landfilled in on-site disposal pits, in an industrial landfill, and in several lagoons on-site. Soils, ground water and river sediments are known to be contaminated. PCB contaminated sludges and soils are estimated to be in excess of 370,000 cubic yards at concentrations greater than 25 mg/kg (dry weight). Ground water and surface water standards for PCBs were exceeded. Potential environmental pathways include contaminated ground water, surface water, soil, and air. The consumption of contaminated fish and wildlife of the food chain is particularly significant at this site because of the close proximity of the Mohawk Indian Reservation, whose residents include large amounts of local fish and wildlife in their diets.

22668 (PB–90-138876/XAB) **Health assessment for Ge-Moreau, South Glen Falls, New York, Region 2. CERCLIS No. NYD980052335. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 13 Jun 1983. 16p. Available from NTIS, PC A03/MF A01.

Approximately 75 drums of liquid wastes containing PCBs were dumped from 1958 to 1968 into an evaporative pit on the G.E.-Moreau Hazardous Waste Site, Glens Falls, Saratoga County, New York. As a result of considerable local and State pressure, G.E. in September 1980 agreed with the State to fund remedial actions at the Moreau/Caputo site and to monitor and maintain the site with security for 30 years after completion of the remedial work. The levels of TCE and other organic compounds are sufficiently high in the local ground-water resources to pose an imminent and insignificant hazard to certain well-water users. Remedial measures need to be implemented immediately to safeguard the public health of any well-water users where levels exceed acute and chronic health guidelines. Past ambient air samples in the pit area revealed exceedingly high values. Since inhalation is a major route of exposure, air sampling in areas where residents and workers are at risk of exposure should be performed, with an adequate sampling strategy based on air-transport modeling. In April, 1979, EPA reported soil PCB levels near the evaporative lagoon as high as 34,000 ppm Arochlor 1016 and 1622 ppm Arochlor 1254. This sampling was done after the 1st cleanup but before further soil was removed in 2 further cleanup efforts. Sampling on-site should be repeated now to see what the residual levels are. On-site soil should also be sampled for other contaminants, including those found in ground water plus heavy metals. It may be necessary to implement immediate remedial measures to safeguard human health.

22669 (PB–90-138884/XAB) **Health assessment for Fulton Terminals Site, Fulton, New York, Region 2. CERCLIS No. NYD980593099. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 21 Jun 1988. 13p. Available from NTIS, PC A03/MF A01.

The Fulton Terminals Site is located in an urban area near the extreme northern edge of Fulton, New York, within 50 feet of the Oswego River. The site served as an oil, asphalt, and chemical storage area from 1936-1977. Sampling and analysis of site soil, sediments, ground water, and surface water revealed a number of Hazardous Substance List contaminants including arsenic, benzene, lead, polychlorinated biphenyls (PCBs), and xylene. The identified pathways for contaminant migration include ground water, surface water, soil, air, and bioaccumulation. Under current conditions the site poses as a potential threat to human health in the event of unauthorized site entry, ingestion of contaminated groundwater, and use of the Oswego River adjacent to the site for recreational uses.

22670 (PB–90-138926/XAB) **Health assessment for Batavia Landfill, Genesee County, Batavia, New York, Region 2. CERCLIS No. NYD980507693. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Batavia Landfill is a 30-acre site located in the Town of Batavia (Genesee County) New York. Drummed and undrummed wastes contributing to the contamination identified at the site include heavy-metal sludges, oils, and organic solvents. Analyses of ground water indicates the presence of heavy metal and volatile organic contaminants (VOCs). Surface-water analysis indicates the presence of heavy metal contaminants. Analyses of off-site ground

water samples taken from private wells, from a well serving a trailer park and from municipal wells serving the Town of Oakfield found iron in concentrations up to 3.2 mg/L and VOCs in concentrations up to 240 microg/L. The Batavia Landfill has created a public health and exposure concern for those who use the contaminated ground water in the vicinity of the landfill. The extent of off-site contaminant migration by the ground water must be determined and a complete site characterization, including a thorough sampling plan of all media is necessary to evaluate the potential environmental impact of the landfill.

22671 (PB–90-138934/XAB) **Health assessment for Byron Barrel, Genesee County, Byron, New York, Region 2. CERCLIS No. NYD980780670. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Byron Barrel and Drum Site is listed on the National Priorities List. Byron Barrel and Drum site contains an abandoned gravel pit and was used as a salvage yard for heavy construction equipment such as graders, bulldozers, cement mixers, and cranes. In 1982 an unidentified individual reported that the site was also used for the disposal of approximately 400 (55-gallon) steel barrels filled with noxious-smelling chemicals. Prior to drum removal, several drums were sampled to characterize the chemical constituents of the wastes. The results of these tests demonstrated that the drums contained organic solvents and degreasing agents including toluene, benzene, xylenes, and methylene chloride. Contamination of on-site ground-water has been confirmed. The amount of soil contamination on site is unknown and should be fully characterized.

22672 (PB–90-138942/XAB) **Health assessment for Anchor Lith Kemko, Hicksville, New York, Region 2. CERCLIS No. NYD001485226. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

Anchor Lith Kemko (ALK) is on the National Priorities List. ALK is located in the Town of Hicksville, Nassau County, New York. 1,1,1-Trichloroethane, trichloroethene, tetrachloroethene and 1,1-dichloroethene are the groundwater contaminants of concern. Two subsurface soil samples collected during monitoring well installation revealed levels of methylene chloride at 490 and 41 micro g/kg and 1,1,1-trichloroethane at <20 and 22 micro g/kg, respectively. The site is considered to be of potential public health concern due to the human health risk caused by the possibility of exposure to hazardous substances via contaminated ground water.

22673 (PB–90-138967/XAB) **Health assessment for Claremont Poly Chemical Corp., Nassau County, Old Bethpage, New York, Region 2. CERCLIS No. NYD002044584. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Claremont Polychemical Site consists of nine acres in Old Bethpage, Nassau County, New York. The facility produced materials used in coloring plastics. Claremont Polychemical operated from 1966 to 1980 and discharged organic solvents, resins, and washing wastes. Previous studies of the Claremont Polychemical Site have revealed contamination of the ground water and soil with tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,2-dichloroethenes, and di(2-ethylhexyl) phthalate. Organic contamination of ground water exceeds New York State and federal standards and guidelines. The predominant contaminant found in the shallow ground water aquifer has been tetrachloroethene. The Old Bethpage Landfill, located west of the site, is a confirmed source of contamination, including tetrachloroethene and other compounds which are also associated with Claremont Polychemical. The site is considered to be a potential health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contamination of public water supply wells in the area.

22674 (PB–90-138983/XAB) **Health assessment for Colesville Landfill, Broome County, Colesville, New York, Region 2. CERCLIS No. NYD980768691. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Colesville Landfill is located in the Town of Colesville, Broome County, New York, and was owned and operated by the county between 1969 and 1984. The sloping 30 acre site received about 9,000 tons of municipal refuse per year. Industrial wastes (organic solvents, aqueous dye waste) were reportedly deposited between 1973 and 1975. Drainage from the landfill is by the North and South Streams which surround the landfill and lead to the Susquehanna River. Homeowner well-monitoring data confirmed the presence of volatile organic contaminants (VOCs) in ground water. Iron, copper, and manganese in private wells exceeded drinking-water standards; however, the levels were typical of area ground water. On-site surface soils are contaminated. The Colesville Landfill poses a potential human health hazard. Although the site is not fenced, its remote location reduces public use of the site, though game animals have free access. Signs should be posted in areas of active leachate seeps to notify the public of the contamination. Direct human exposure to contaminated ground water is minimal.

22675 (PB–90-139007/XAB) **Health assessment for the Endicott Wellfield Site, Broome County, New York, Region 2. CERCLIS No. NYD980780746. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 23 Feb 1988. 16p. Available from NTIS, PC A03/MF A01.

The Endicott Wellfield site is located near the southwestern boundary of the Village of Endicott in Broome County, New York. The nine contaminants of concern found at the wellfield site are chloroethane, vinyl chloride, trans-1,2 dichloroethene, 1,1-dichloroethane, trichloroethene, chlorobenzene, benzene, and tetrachloroethene. The levels of these compounds in the well are sufficiently high to pose a public health threat.

22676 (PB–90-139023/XAB) **Health assessment for Facet Enterprises, Inc., Chemung County, Elmira Heights, New York, Region 2. CERCLIS No. NYD073675514. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 1 May 1989. 14p. Available from NTIS, PC A03/MF A01.

The Facet Enterprises, Inc. plant is located on a 31-acre site in the town of Elmira Heights, Chemung County, N.Y. Significant levels of volatile organic compounds (VOCs) were detected in on-site monitoring wells including trichloroethene (TCE), trans-1,2-dichloroethene, vinyl chloride, and 1,1,1-trichloroethane. TCE has been detected in the ground water approximately 1,500 feet southeast of the plant site. The Facet site presents a potential public health concern to on-site workers and the surrounding community, particularly with respect to the existing contamination of the public drinking water supply.

22677 (PB–90-139049/XAB) **Health assessment for Johnstown City Landfill, Fulton County, Johnstown, New York, Region 2. CERCLIS No. NYD980506927. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Johnstown City Landfill is on the National Priorities List. It is a municipally operated unlined landfill. Significant amounts of industrial wastes containing chromium trimmings, other heavy metals, and solvents have been deposited in the landfill. The sewage sludge is known to contain high concentrations of chromium, iron, and lead. The Johnstown City Landfill represents a potential human health hazard. Ground-water contamination, which may affect private wells in the vicinity of this site is presently the greatest area of concern and must be clearly addressed in all future work.

22678 (PB–90-139072/XAB) **Health assessment for Kentucky Avenue Wellfield National Priorities List (NPL) site, Horseheads, Chemung County, New York, Region 2. CERCLIS No. NYD981560428. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 31 Jan 1989. 11p. Available from NTIS, PC A03/MF A01.

The Kentucky Avenue Wellfield is a National Priorities List site located near Horseheads, New York. The wellfield was developed in 1962 as part of the Elmira Water Board public water-supply system. The primary contaminants at the site are trichloroethene (TCE) and trans-1,2-dichloroethene. Although the source(s) of the contamination has not been located, several industrial facilities in the area are suspect. The potential environmental pathways at the

site are related to ground-water, sediment, and surface water. The potential pathways for human exposure include ingestion of contaminated ground-water by users of private wells, dermal absorption of contaminants found in contaminated ground-water, and inhalation of volatile organic compounds during domestic activities. ATSDR has concluded that the site poses a potential health concern because risk to humans exists from possible exposure to hazardous substances.

22679 (PB–90-139080/XAB) **Health assessment for Liberty Industrial Finishing, Nassau County, Farmingdale, New York, Region 2. CERCLIS No. NYD000337295. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Liberty Industrial Finishing (LIF) Site, located in the Town of Farmingdale, Nassau County, New York is on the National Priorities List. LIF operated continuously from 1948 to 1978 with operations including electroplating, dying, and painting. LIF used two ground-water recharge basins as lagoons for discharging treated waste water. The data and historical site operations indicate that cadmium, chromium, and cyanide are the major inorganic contaminants. Based on the available information, the site is considered to be of potential public health concern.

22680 (PB–90-139106/XAB) **Health assessment for Ludlow Landfill National Priorities List (NPL) site, Clayville, Oneida County, New York, Region 2. CERCLIS No. NYD013468939. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 25 Aug 1988. 13p. Available from NTIS, PC A03/MF A01.

The Ludlow Landfill is a National Priorities List site located in Clayville, Oneida County, New York. The landfill was in operation for over 20 years and was closed February 15, 1988. At the time of its closure only municipal refuse was being accepted for disposal, but in the past, some industrial wastes were deposited in the landfill. The primary contaminants found at the site are polychlorinated biphenyls (PCBs) and volatile organic compounds. Off-site migration of contaminants can occur via ground water, surface water, and suspended sediments. Potential adverse effects on public health could occur if PCBs or other site-related chemicals migrated off-site in ground water and contaminated downgradient potable-well supplies. Human exposure to PCB-contaminated soils in the wetlands or the consumption of biota from the wetlands are also pathways of potential public health concern.

22681 (PB–90-139114/XAB) **Health assessment for Malta Rocket Test Site, Saratoga County, Malta, New York, Region 2. CERCLIS No. NYD980535124. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 13p. Available from NTIS, PC A03/MF A01.

The Malta Rocket Fuel Test Station is listed by the USEPA on the National Priorities List. The General Electric Company tested operations at the site as a contractor to the U.S. Government. Beginning in December 1974, and continuing until December 1979, Exxon Nuclear Company, Inc. conducted operations at a building on the site. During the course of its operations, Exxon handled several hazardous chemicals including methylethyl ketone, acetone, tetrachloroethene, and toluene. Various site inspections, investigations and engineering studies have been conducted at the site. Ground water collected from monitoring wells on-site is contaminated with chloroform, carbon tetrachloride, and trichloroethene. In April 1985, sampling of ground water supplies serving the site demonstrated significant drinking-water contamination with concentrations of carbon tetrachloride up to 220 micro g/L, chloroform up to 25 micro g/L, PCBs up to 1.3 micro g/L, trichlorethene up to 120 micro g/L, and boron up to 140 micro g/L. The site has been the subject of several investigations, however, none have been comprehensive. The site should be the subject of a complete remedial investigation/feasibility study before a full health assessment can be prepared.

22682 (PB–90-139155/XAB) **Health assessment for Nepera Chemical Co., Orange County, Maybrook, New York, Region 2. CERCLIS No. NYD000511451. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Nepera Chemical Company's Maybrook site is an inactive 23-acre site located southwest of Maybrook, New York. The site was used by Nepera from 1953 to 1968 for the disposal of industrial waste generated by Nepera's Harriman, New York, plant which produced pharmaceutical chemicals, hydrogels, and pyridine-based industrial-chemical intermediates. Test borings taken from the former lagoon sites indicate the presence of subsurface waste materials. In five lagoons the waste materials are stained with a dark oily substance the thickness of which varies, by lagoon, from one to eight feet. Laboratory analysis of the material found acetone, toluene, (total) xylenes, methyl ethyl ketone (MEK), aniline, pyridines (alpha-picoline, 2-alpha-picoline), cyanide, and metals. Most of the contaminants associated with Nepera Chemical have been found on-site at levels that exceed existing New York State and Federal Standards or Guidelines for ground, surface, and drinking water. The extent of the contaminated ground water plume off-site is not known and raises concerns about its possible impact on local drinking-water supplies, both residential and public. As part of the remedial investigation, further monitoring of off-site wells for the unique site-specific compounds will be undertaken.

22683 (PB–90-139163/XAB) **Health assessment for Niagara County Refuse Disposal, Niagara County, New York, Region 2. CERCLIS No. NYD000514257. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Niagara County Refuse Disposal Site, a National Priorities List Site, occupies approximately 50 acres in the Town of Wheatfield, Niagara County, New York. Surface drainage is conveyed from the site by ditches and enclosed drains that carry runoff south to the Niagara River or north to Black Creek. The site received industrial solid and chemical wastes, largely of unknown composition, from 1969 to 1976. The Niagara County Refuse Site has been investigated several times since 1973. Analytical results among the studies are conflicting and analytical quality control is poor. Heavy metals have been found in leachate discharging to the Niagara River. Sediment samples have high levels of bis(2-ethylhexyl)phthalate, polycyclic aromatic hydrocarbons, and low levels of PCBs. The site poses a potential health threat to people who use the Niagara River for fishing, recreation, and drinking water and to on-site workers during any remedial work.

22684 (PB–90-139171/XAB) **Health assessment for North Sea Landfill, Suffolk County, North Sea, New York, Region 2. CERCLIS No. NYD980762520. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The North Sea Landfill, located in Southhampton, Suffolk County, New York, is an active municipal landfill approximately 110 acres in size. A leachate plume including chlorinated solvents and heavy metals emanates from the landfill and is traveling in a northwesterly direction to a brackish inland cove (Fish Cove) approximately one-half mile distant. In the past, ground-water on-site was found to be contaminated with 17 micro g/1 (ppb) of vinyl chloride. Chlorinated organic chemicals including vinyl chloride have been detected both on- and off-site at lower concentrations. Toluene and lead have been detected in ground-water on and off-site at concentrations from 1 to 6 micro g/L and 27 to 740 micro g/L, respectively. The potential public health concerns of primary importance are exposure to hazardous materials on-site for employees and exposures through contaminated ground water for the off-site population.

22685 (PB–90-139197/XAB) **Health assessment for Olean Well Field National Priorities List (NPL) site, Olean Cattaraugus County, New York, Region 2. CERCLIS No. NYD980528657. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 21 Nov 1988. 15p. Available from NTIS, PC A03/MF A01.

The Olean Well Field National Priorities List site is located in the City and Town of Olean, Cattaraugus County, New York. Trichloroethylene contamination of three municipal water wells was discovered in January 1981. The City of Olean discontinued the use of the three wells and obtained potable water from an older surface-water treatment plant. Private potable water wells with levels of contamination higher than acceptable levels are being treated with activated carbon. The Record of Decision signed by the U.S.

Environmental Protection Agency on September 24, 1985 requires two primary actions: the treatment of ground water obtained from the three municipal wells for use as public water supply and the extension of the municipal-water-distribution system to 93 affected and potentially affected residents using private wells within the site. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

22686 (PB–90-139213/XAB) **Health assessment for Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico, Region 2. CERCLIS No. PRS187147. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 13p. Available from NTIS, PC A03/MF A01.

The Vega Alta Public Supply Wells Site is a public water supply wellfield located in the municipality of Vega Alta, Puerto Rico. Based on data collected from 1983 to 1985, the ground water is contaminated with volatile organic chemicals (VOCs), notably trichloroethylene, tetrachloroethylene, and 1,2-trans-dichloroethylene. A remediation alternative selected in a Record of Decision dated September 29, 1987 calls for treatment of 4 of the more highly contaminated wells and shutting down 2 others. Remediation efforts are to include air stripping and possibly treatment by carbon adsorption. Monitoring of the effectiveness of these efforts will determined their adequacy to bring the quality of the tap water to acceptable levels. It is not known whether the water currently supplied through the municipality has elevated concentrations of VOCs. Therefore, based on the limited information available, ATSDR has concluded that the Vega Alta Wells site is of public health concern.

22687 (PB–90-139957/XAB) **Health assessment for RCA del Caribe, Inc., Barceloneta, Puerto Rico, Region 2. CERCLIS No. PRD090370537. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 7p. Available from NTIS, PC A02/MF A01.

The RCA del Caribe site is listed on the National Priorities List. The 20-acre site is the former location of RCA's television screen etching mask production facility. Wastes generated were disposed of in four holding lagoons. The environmental contamination on-site consists of chromium (160 ppm), beryllium (6 ppm), selenium (9 ppm), and iron (23,100 ppm) in lagoon sediments. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ground water.

22688 (PB–90-140005/XAB) **Health assessment for Barceloneta Landfill, Florida Afuetra, Puerto Rico, Region 2. CERCLIS No. PRD98059129. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 7p. Available from NTIS, PC A02/MF A01.

The Barceloneta Landfill Site (BLS) is located in Florida Afuera, Puerto Rico. BLS is an active municipal/industrial site. Approximately 300 tons of hazardous wastes have been disposed in sink holes, which are approximately 100 feet deep. Preliminary on-site sampling results have identified various volatile organic compounds. They include: chloroform (2 ppm in sludge), toluene (31 ppb in surface water), phenols (3 ppm in sludge), and methylene chloride (52 ppb in sludge). Other contaminants identified on-site in water runoff and sludge include aluminum, cobalt, iron, manganese, zinc, mercury, and lead. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Direct contact and ingestion of ground water, surface water, soil, and sediment are the most likely exposure routes. Inhalation of volatilized contaminants or contaminants entrained in air by area residents is another exposure route that may pose a public health concern. Ingestion of fish that bioaccumulate site contaminants may pose a potential for public health concern because it was reported that fish is a food staple for the area.

22689 (PB–90-140013/XAB) **Health assessment for York Oil Company, Moira, New York, Region 2. CERCLIS No. NYD000511733. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 8 Jul 1988. 14p. Available from NTIS, PC A03/MF A01.

York Oil Company site is approximately 17 acres located in the Town of Moira, northwestern Franklin County, in upper New York State. York Oil Company was a waste-oil recycling facility which operated for approximately 18 years, collecting and refining oils from the New England area. Off-site migration of contaminants has occurred via groundwater and overland flow. There are thirteen residential wells within one-half mile of the site. Currently, the residential wells are not contaminated by compounds from the site; however, the contamination appears to be migrating toward three residential wells downgradient of the site. The site poses a public health concern as a result of the potential for indirect ingestion and direct contact exposures to: Polychlorinated biphenyl (PCB)- and lead-contaminated wastes on-site, PCB-contaminated soil on-site, and PCB-contaminated sediments off-site. The potential health threats posed by inhalation exposures to vapors, fumes, and dusts from the site and ingestion of contaminated food-chain entities could not be evaluated.

22690 (PB–90-140039/XAB) **Health assessment for Warwick Landfill, Orange County, Warwick, New York, Region 2. CERCLIS No. NYD980506679. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

Warwick Landfill is located in the southeastern portion of Orange County in the Town of Warwick, New York. The 13-acre municipal landfill was operated as a refuse-disposal facility from the late 1950s until 1979 when the New York State Department of Environmental Conservation issued a restraining order. Industrial waste was allegedly disposed at the site. Environmental contamination has been confirmed in on-site ground-water monitoring wells and leachate seeps. Historically, sampling has included: surface water (Long Pond Inn), leachate/surface water, ground-water on-site, private wells off-site (5 homes), and sediment and soils on-site. Contamination of surface water by organics and inorganics has been identified in seeps off-site. Ground-water contamination has been identified on-site in all four of the shallow monitoring wells. The site represents a potential public health threat. Monitoring of private wells should continue to ensure domestic water sources for the area residents.

22691 (PB–90-140047/XAB) **Health assessment for Volney Landfill, Volney, New York, Region 2. CERCLIS No. NYD980509376. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Jul 1987. 12p. Available from NTIS, PC A03/MF A01.

The Volney Landfill National Priority List site was evaluated for the potential health threat to area residents from contamination of ground water, surface water, and soil. Levels of arsenic, cyanide, benzene, and other Hazardous Substance List contaminants may pose a public health threat to area residents. The widespread use of ground water by local residents implicates this contaminated medium as the most likely source for human exposure to contaminants. Surface-water and sediment contamination should not pose a health risk, although further examination of bioaccumulation in aquatic food species is recommended to properly assess these issues. A Feasibility Study summarizing remedial cleanup alternatives for the Volney Landfill Site was also addressed. Examination of the eight proposed alternatives reveal that none include provisions for an alternative water source for area residents and, therefore, fail to adequately address all public health concerns. All alternatives failed to address contamination of bedrock and stream sediments.

22692 (PB–90-140070/XAB) **Health assessment for Tronic Plating Co. Inc., Suffolk County, Farmingdale, New York, Region 2. CERCLIS No. NYD002059517. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 10p. Available from NTIS, PC A02/MF A01.

Tronic Plating, an electroplating facility in operation from 1968 to 1984 was located in Farmingdale, Township of Babylon, Suffolk County, New York. During its operation the facility discharged industrial wastes into a sanitary pit and four below-ground leaching pools. Storm drains located approximately 33-40 feet from the northern rear door of the operation were also allegedly utilized for the disposal of potentially hazardous effluent. These activities are believed to have resulted in contamination of ground water with

heavy metals. At present the contamination of soil and ground water with heavy metals or other compounds associated with the facility can only be assumed since these media on and around the site have yet to be tested. The Tronic Plating site represents a potential human health threat. The Remedial Investigation will fully evaluate both inorganic and organic contamination at the site, including extensive sampling for those compounds on EPA's Target Compound List for water and soil. Until such results are available, the extent of environmental contamination due to on-site subsurface discharge of hazardous effluents cannot be determined.

22693 (PB–90-140088/XAB) **Health assessment for Syosset Landfill, Nassau County, Syosset, New York, Region 2. CERCLIS No. NYD000511360. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 14p. Available from NTIS, PC A03/MF A01.

The Syosset Landfill, located in the Town of Oyster Bay, Nassau County, New York is approximately forty-four acres in size. From 1936 to 1974 the landfill received mixed municipal refuse, cesspool pump-out wastes, and industrial wastes. Ground water on-site is contaminated with organic and inorganic compounds including elevated levels of heavy metals (lead, arsenic, chromium and cadmium) reflective of industrial-waste disposal. A public water-supply well near the landfill was closed in 1974 due to problems allegedly resulting from the leachate plume emanating from the landfill. Due to the high permeability of soils contaminant migration through ground water can be rapid. Gas vents at the landfill side of the border contained low levels of vinyl chloride, trans-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene and tetrachloroethene. Higher levels of benzene, toluene, ethylbenzene and xylenes were also detected. A review of data indicates the most-probable pathways of exposure to contaminants originating at the landfill would be from inhalation of migrating gas and use of contaminated ground water.

22694 (PB–90-140096/XAB) **Health assessment for Suffern Well Field NPL (National Priorities List) site, Village of Suffern, Rockland County, New York, Region 2. CERCLIS No. NYD980780878. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 May 1988. 13p. Available from NTIS, PC A03/MF A01.

The Suffern Well Field is a National Priorities List site located in the northwestern portion of the village of Suffern, Rockland County, New York. The contaminants found at the site consist of 1,1,1-trichloroethane (TCEA) in the ground-water and coal-gasification wastes which have been found in the ground-water and in the subsurface soil. Because of the potential for future contamination, periodic monitoring of the wells for a reasonable time to ensure that no contamination occurs is needed to ensure protection of human health.

22695 (PB–90-140104/XAB) **Health assessment for Solvent Savers, Chenango County, Linckiaen, New York, Region 2. CERCLIS No. NYD980421176. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Solvent Savers site, a National Priorities List site, is located on a rural tract of land, in Lincklaen, Chenango County, New York. Organic chemicals found in groundwater include 1,1,1-trichloroethane, trichloroethylene, benzene, toluene, chloroform, phenol, trans-1,2-dichloroethene, and vinyl chloride. Analysis of one on-site soil sample showed the presence of PCBs. Inorganic chemicals (metals) identified in soil samples include cyanide, lead, arsenic and cadmium. The site poses a potential public health threat to residents on private water supplies adjacent to the site, to persons using Mud Creek (i.e., fishing, swimming), and to on-site workers during any remedial work.

22696 (PB–90-140112/XAB) **Health assessment for SMS Instruments, Inc., Deer Park, New York, Region 2. CERCLIS No. NYD001533165. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

SMS Instruments is located in a light industrial area in Deer Park, Suffolk County, New York. The company's main business is overhauling military aircraft components. Historically, degreasing and paint-stripping agents as well as fluorescent-oil dyes were used. Waste streams include naphtha and petroleum distillates, heavy metals, and a variety of halogenated and non-halogenated solvents. In 1979-1980, testing performed by Suffolk County Department of Health indicated heavy-metal contamination (iron, 61 mg/L; chromium, 29 mg/L; zinc, 56 mg/L; lead, 45 mg/L; and cadmium, 25 mg/L) in on-site leaching pools. Ground-water monitoring wells have indicate high levels of solvents: xylene, 12,000 micro g/L; toluene, 8,300 micro g/L; benzene, 350 micro g/L; 1,1,1-trichloroethane, 2,300 micro g/L; 1,1,2-trichloroethene, 2,200 micro g/L; and dichloromethane, 130 micro g/L. The site has potential public health impacts.

22697 (PB–90-140120/XAB) **Health assessment for Sinclair Refinery, Allegany County, Wellsville, New York, Region 2. CERCLIS No. NYD980535125. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Sinclair Refinery Site in Allegany County, Wellsville, New York consists of a 90-acre former refinery site and an associated 11.5-acre landfill. Ground water and surface water and soils were found to contain elevated concentrations of organic and inorganic chemicals. A total of 152 compounds have been detected at the site at various times, with most of the organic compounds being petroleum-based. Detected inorganic compounds include arsenic, chromium and lead. The organic chemicals of concern are generally above expected environmental levels, particularly for subsurface soil samples. Minor contamination was observed in ground water monitoring wells. The sampling described in the Feasibility Study must be completed to characterize fully the current environmental contamination on-site and off-site. The data are required to assess fully the potential health impacts and to design final remedial activities.

22698 (PB–90-140138/XAB) **Health assessment for Sarney Property, Amenia, New York, Region 2. CERCLIS No. NYD980535165. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 13p. Available from NTIS, PC A03/MF A01.

The Sarney Property is on the National Priorities List. Ground water beneath the site is contaminated with toluene, 1,2-dichloroethene, methyl ethyl ketone, vinyl chloride, trans-1,2-dichloroethene, chlorobenzene, and trichloroethene. Since potential exposures from these wells could occur in the future, periodic monitoring is recommended until permanent remediation has been completed.

22699 (PB–90-140146/XAB) **Health assessment for Rowe Industries, Suffolk County, Sag Harbor, New York, Region 2. CERCLIS No. NYD981486954. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 10p. Available from NTIS, PC A02/MF A01.

Rowe Industries is on the National Priorities List. The site was used for the manufacture of small motors for appliances, such as tools and hairdryers. Tetrachloroethene, trichloroethene and 1,1,1-trichloroethane are the contaminants of greatest concern at the site. Human exposures associated with the use of ground water from residential wells has been eliminated by the installation of the public water supply. The site poses a limited public health threat to adjacent residences through exposure to contaminants by incidental contact with ground water and soil gas.

22700 (PB–90-140153/XAB) **Health assessment for Robintech Site, Broome County, Vestal, New York, Region 2. CERCLIS No. NYD002232957. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

The Robintech, Inc. Site, located in the Town of Vestal, Broome County, New York is on the National Priorities List. The company presently manufactures PVC (polyvinyl chloride) pipe from PVC resin and assembles plastic-coated cable at the facility. Groundwater data from production wells on-site showed the presence of numerous volatile organic compounds and metals. Surface soil, surface water, and sediment samples taken both on-site and off-site have shown volatile organics and inorganics (metals) present at elevated levels. The site poses a potential public health threat to

users of the Vestal municipal wells, and users of the adjacent recreational facility. The site is also a public health threat to employees and on-site workers during the investigations and remedial work.

22701 (PB–90-140161/XAB) **Health assessment for richardson Hill Landfill, Delaware County, Sidney, New York, Region 2. CERCLIS No. NYD980507735. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 14p. Available from NTIS, PC A03/MF A01.

The Richardson Hill Road Landfill has been accepted as an NPL site. A private hauler disposed of waste oil containing solvents and PCBs from the Bendix plant located in the Town of Sidney in this pit. The drainage for the area flows south and empties into the Cannonsville Reservoir six miles downstream. The reservoir supplies drinking water for New York City. However, the contaminant concentration drops dramatically with distance from the site. There are 13 compounds that exceed existing NYS and federal drinking water and environmental standards and guidelines. However, the full extent of the contamination has not yet been defined. The site represents a potential threat to the public health, although present human exposure appears minimal.

22702 (PB–90-140179/XAB) **Health assessment for Ramapo Town Landfill, Rockland County, Ramapo, New York, Region 2. CERCLIS No. NYD000511493. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). 30 Jun 1989. 11p. Available from NTIS, PC A03/MF A01.

The Town of Ramapo Sanitary Landfill, a USEPA National Priorities List Site, is located in the Torne Brook Valley, a one-quarter mile northeast of the Ramapo River and one mile northeast of the Village of Hillburn. Since opening in 1971, the site has received primarily municipal refuse although industrial sludge disposal occurs, and the site has been linked with illegal hazardous-waste haulers. Sampling conducted to date has been limited to ground water and surface water. Analysis reveals contamination of both media with heavy metals, phenols and volatile organic compounds. Additionally, surface water discharges were found to contain PAHs, phthalates and oil/grease. Chemical contamination from the site presents a potential threat to public health. Regular monitoring of public drinking water wells has begun; monitoring of private wells should also occur on a regular basis.

22703 (PB–90-140435/XAB) **Health assessment for Port Washington Landfill, North Hempstead, New York, Region 2. CERCLIS No. NYD980654206. Preliminary report.** New York State Dept. of Health, Albany, NY (USA). Jun 1989. 14p. Available from NTIS, PC A03/MF A01.

The Port Washington Landfill is located in the northwestern portion of Nassau County, New York. Prior to the Town of North Hempstead's purchase of the property in 1973, the site was used from the late 1880s as a sand and gravel mine and as a construction and demolition debris landfill. Operation of the landfill during the 1970s resulted in the generation of an off-site soil gas plume composed of methane and volatile organic compounds. Of the volatile compounds, vinyl chloride is of special concern because of its presence in the on-site soil gas at high concentrations and its carcinogenicity. A variety of volatile organic compounds have been detected in the ground water, leachate, and ambient and subsurface air. All of the contaminants found in ground water exceed New York State drinking water standards. Elevated brain cancer incidence was found in males in the study area and was limited in time from 1978 to 1987. Whether or not the cases are related to the airborne contaminants is unknown. The cause and effect relationship should be investigated by examining brain-cancer incidence near landfills with similar vapor-emission problems.

22704 (PB–90-855859/XAB) **Water treatment by reverse osmosis. November 1970-October 1989 (Citations from the US Patent data base). Report for November 1970-October 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 60p. Available from NTISPC N01/MF N01.

This bibliography contains citations of selected patents concerning water purification systems and components using reverse-osmosis technology. Patents include systems and devices for sea water, waste water, and drinking water purification. Topics include complete purification systems, valves and distribution components, membranes, supports, storage units, and monitors. Water purification systems using activated charcoal are referenced in a related published bibliography. (Contains 103 citations fully indexed and including a title list.)

22705 (PB–90-856733/XAB) **Activated charcoal filters: Water treatment, pollution control, and industrial applications. October 1970-October 1989 (Citations from the US Patent data base). Report for October 1970-October 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 80p. Available from NTISPC N01/MF N01.

Supersedes PB–89-869150.

This bibliography contains citations of selected patents concerning activated charcoal filters and their applications in water treatment, pollution control, and industrial processes. Filtering methods and equipment for air and water purification, industrial distillation and extraction, industrial leaching, and filtration of toxic materials and contaminants are described. Applications include drinking water purification, filtering beverages, production of polymer materials, solvent and metal recovery, waste conversion, automotive fuel and exhaust systems, swimming-pool filtration, tobacco-smoke filters, kitchen ventilators, medical filtration treatment, and odor-absorbing materials. (This updated bibliography contains 173 citations, 12 of which are new entries to the previous edition.)

22706 (PNL–7257) **Environmental monitoring master sampling schedule, January–December 1990.** Bisping, L.E. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 52p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007615. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Environmental monitoring of the Hanford Site is conducted by the Pacific Northwest Laboratory (PNL) for the US Department of Energy (DOE). This document contains the planned schedule for routine sample collection for calendar year 1990 for the Environment Surveillance and Ground-Water Monitoring Projects. This schedule is subject to modification during the year in response to changes in Site operations, program requirements, and the nature of the observed results. Operational limitations such as weather, mechanical failures, sample availability, etc., may also require schedule modifications. Changes will be documented in the respective project files, but this plan will not be reissued. The purpose of these monitoring projects is to evaluate levels of radioactive and nonradioactive pollutants in the Hanford environs. This schedule includes ground-water sampling performed by PNL for environmental surveillance of the Hanford Site.

22707 (STUK-A–83) **Radioactivity of Focus vesiculosus along the Finnish coast in 1987: Supplement 9 to annual report 1987 (STUK-A-74).** Ilus, E.; Klemola, S.; Sjoeblom, K.-L.; Ikaeheimonen, T.K. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). May 1988. 36p. Order Number DE90619476. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Samples of Fucus vesiculosus were collected along the west and south coast of Finland at 25 stations in June-October 1987. More detailed surveys were conducted in the marine areas surrounding the nuclear power stations at Olkiluoto and Loviisa. The samples were analysed for gamma-emitting radionuclides and partly also for ^{90}Sr and transuranic elements. From the twelve gamma-emitting radionuclides detected in the Focus samples, ^{40}K, ^{106}Ru, ^{110m}Ag, ^{134}Cs and ^{137}Cs were found in nearly all samples. ^{54}Mn and ^{65}Zn were almost regularly detected in the samples from the Olkiluoto and Loviisa areas and commonly also along the whole coast, whereas ^{60}Co was rarely found at the coastal stations outside the immediate vicinities of the power stations. The activity concentrations of ^{137}Cs varied in the Fucus samples from 80 to 670 Bq kg^{-1} dry weight. The highest values were found in the Loviisa area and in the eastern part of the Gulf of Finland and the lowest in the Archipelago Sea. The values reflect differences in the amounts of local fallout and runoff, but also the transport of radionuclides by river waters and currents in the sea. The results provide evidence of the indicator value of Fucus vesiculosus in the monitoring of radioactive substances, both in the environs of the nuclear power

stations and also in studies regarding the dispersion and behaviour of fallout nuclides in the marine environment. Among the great number of samples taken in the Finnish monitoring programme, Fucus was the most sensitive bioindicator of ^{60}Co and ^{65}Zn, and thus enabled detection of these radionuclides in the fallout from Chernobyl.

22708 **The geochemistry of fallout plutonium in the North Atlantic: II. $^{240}Pu/^{239}Pu$ ratios and their significance.** Buesseler, K.O. (Woods Hole Oceanographic Institution, MA (USA)); Sholkovitz, E.R. *Geochimica et Cosmochimica Acta (USA),* 51(10): 2623-2637 (Oct 1987). DOE Contract FG02-85ER60358.

A systematic decrease in the $^{240}Pu/^{239}Pu$ ratios in marine sediments is found with increasing water depth along a transect of cores between Woods Hole and Bermuda. The $^{240}Pu/^{239}Pu$ atom ratios range from similarly ordered 0.18 on the shelf to similarly ordered 0.10 at 5000 m but do not change with depth in individual cores. A model is presented which can account for the range of $^{240}Pu/^{239}Pu$ ratios found in this and other similar studies. The authors propose that there have been at least two distinct sources of fallout Pu to this region. The major source of Pu is global stratospheric fallout, characterized by a $^{240}Pu/^{239}Pu$ ratio of 0.18 and a relatively long residence time in seawater. The second source is characterized by a much lower $^{240}Pu/^{239}Pu$ ratio, and relative to global fallout it must have been much more efficiently removed from the water column to deep-sea sediments. They suggest that surface-based low yield testing at the Nevada Test Site is the only source of low ratio fallout Pu which could account for the timing, inventories, and refractory characteristics of this second component of fallout Pu inputs to the North Atlantic.

22709 **The geochemistry of fallout plutonium in the North Atlantic: I. A pore water study in shelf, slope and deep-sea sediments.** Buesseler, K.O. (Woods Hole Oceanographic Institution, MA (USA)); Sholkovitz, E.R. *Geochimica et Cosmochimica Acta (USA),* 51(10): 2605-2622 (Oct 1987). DOE Contract FG02-85ER60358.

The distribution of fallout plutonium between pore waters and sediments in the Northwest Atlantic is examined in order better to define the potential for Pu migration from and within marine sediments. Along a transect of seven cores collected between Woods Hole and Bermuda, the solid phase $^{239,240}Pu$, $^{210}Pb^{ex}$ and ^{137}Cs results do not suggest that any of these tracers are preferentially mobile within the cores. Pore water Pu activities appear to be controlled primarily by the distribution of Pu in the solid phase, with an operationally determined distribution coefficient, K_d, in the range of 0.2-23 x 10^6. There is a trend in the K_ds along the transect, with higher values in the 10^4-10^5 range on the shelf and slope, to lower values < 10^4 in the deep-sea cores. The exact mechanism for this shift has yet to be determined. While the Pu pore water activity at the sediment-water interface is elevated over near bottom water activities, the potential for Pu remobilization out of the sediments is small. Sediment mixing models are not significantly altered by the inclusion of Pu diffusion terms since the pore water terms are so small relative to typical sediment mixing rates.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

Refer also to citation(s) 22776

5502 Biochemistry

Refer also to citation(s) 21576, 21581, 22750, 22755, 22861

22710 (DOE/ER/13053–5) **Energetics of end product excretion in anaerobic bacteria and the metabolism of fatty acids by Syntrophomonas wolfei: Progress report, December 16, 1985–November 15, 1986.** McInerney, M.J. Oklahoma Univ., Norman, OK (USA). [1986]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-83ER13053. Order Number DE90007661. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The study of anaerobic hydrogen-producing syntrophic bacteria is important for several reasons. These bacteria degrade fatty acids which are important intermediates in anaerobic degradation and methanogenesis. The rate and extent of anaerobic degradation of complex polymeric materials often depends on the activity of these organisms. The production of H_2 during anaerobic fatty acid degradation is energetically favorable only when H_2 is maintained at a low level by another bacterium such as a H_2- using methanogen. Thus, the fatty acid-degrading syntrophic associations serve as excellent models to study the biochemical aspects of mutualism. The fatty acid-degrading syntrophic bacteria are very slow growers since little free energy is released during fatty acid degradation. These bacteria must have very efficient energy conservation systems which are not understood at this time. Further study of these organisms will provide useful information on bioenergetics of living systems. We have chosen to study the metabolism and energetics of the anaerobic, syntrophic, fatty acid degrader, Syntrophomonas wolfei. This organism is the best characterized syntrophic bacterium and serves as an appropriate model organism.

22711 (DOE/ER/13086–T1) **[Molecular mechanism of energy transduction by plant membrane proteins]: Progress report, June 15, 1983–June 15, 1984.** Wisconsin Univ., Madison, WI (USA). 1984. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-83ER13086. Order Number DE90008433. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In anticipation of future needs, one of the first projects I initiated was the production of antibody against the ATPase. I chose to produce antibody against the *Neurospora* enzyme mainly because it was readily available in large amounts, and I wished to become familiar myself with the methodology of producing and using antibodies. In addition, there was a hope that there would be sufficient cross-reactivity with the higher plant enzyme, to allow its use with the higher plant project as well. The postdoctoral associate I hired has had extensive experience with both polyclonal and monoclonal antibodies, and has done an excellent job of getting this project off the ground. We decided to produce polyclonal antibody rather than monoclonal antibodies because we have already committed substantial time and money in a HPLC and protein sequenator we didn't want to waste the additional time (6-12 months), equipment and space that it would take to establish a working monoclonal facility, and polyclonal antibody is frequently more sensitive and yields a better immunoprecipitation.

22712 (DOE/ER/13368–6) **Enzymology of acetone-butanol-isopropanol formation: Progress report, February 1, 1989–January 31, 1990.** Chen, Jiann-Shin. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13368. Order Number DE90007660. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objectives of the project are to elucidate first the molecular properties of solvent-forming enzymes and then to apply the information gained from the enzymological study to elucidate the control mechanisms for the solvent-producing pathways and the expression of solvent-production genes. Our research primarily involves two strains of Clostridium beijerinckii (Clostridium butylicum): C. beijerinckii NRRL B593 which produces isopropanol in addition to acetone, n-butanol, and ethanol, and C. beijerinckii NRRL B592 which produces acetone, n-butanol and ethanol, but not isopropanol. More recently, we started to include another solvent-producing organism, Bacillus macerans, in our study. B. macerans produces a high level of acetone and ethanol under anaerobic conditions. Because B. macerans does not produce butyric acid and butanol, it has a less complex metabolic pathway than that of C. acetobutylicum and C. beijerinckii. This simpler metabolic pathway serves as a useful system for comparison in our study of the enzymology and regulation of solvent formation.

22713 (DOE/ER/13496–4) **[The structure of pectins from cotton suspension culture cell walls]: Progress report.** Mort, A. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Biochemistry.

[1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER13496. Order Number DE90007667. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have made progress on several projects to do with determining the structure of pectins. These include: (1) Devising a new sensitive method to determine the degree of methyl esterification (DOM) of pectins; (2) solubilization of all of RGI from cotton cell walls; (3) solubilization of RGII from cotton cell walls; (4) characterization of xyloglucan from cotton cell walls; and (5) investigation giving an indication of a cross-link between extension and pectin.

22714 (DOE/ER/13574–5) **Ethanologenic enzymes of Zymomonas mobilis: Progress report.** Ingram, L.O. Florida Univ., Gainesville, FL (USA). Dept. of Microbiology and Cell Science. 13 Feb 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER13574. Order Number DE90007663. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this study, we have proposed to investigate the mechanisms which permit the high level expression of the ethanologenic enzymes from Zymomonas mobilis (PDC, ADHI, ADHII). This research is continuing essentially as proposed in the original grant except that the scope has been expanded to include additional glycolytic enzymes from the lower portion of the Entner-Doudoroff pathway which are also highly expressed. Several enzymes which are expressed only at moderate levels are being examined for comparison (tryptophan biosynthesis, acid phosphatase).

22715 (DOE/ER/60649–T2) **[Development of gamma-emitting, receptor-binding radiotracers for imaging the brain and pancreas]: Progress report.** Reba, R.C. George Washington Univ., Washington, DC (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER60649. Order Number DE90008314. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our objectives were to (1) synthesize analogues of 4-IQNB which exhibit lower lipophilicity, preferably similar to that of QNB; (2) prepare F-18 analogues of QNB and (3) prepare analogues of 3-quinuclidinyl benzilate containing a lipophilic chelate Tc-99m. 11 refs., 1 tab.

22716 (LBL–28225) **Structures of peptide families by nuclear magnetic resonance spectroscopy and distance geometry.** Pease, J.H. Lawrence Berkeley Lab., CA (USA). Dec 1989. 176p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00098. Grant DMB 88-15998;DMB 86-09035. Order Number DE90007760. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The three dimensional structures of several small peptides were determined using a combination of ^{1}H nuclear magnetic resonance (NMR) and distance geometry calculations. These techniques were found to be particularly helpful for analyzing structural differences between related peptides since all of the peptides' ^{1}H NMR spectra are very similar. The structures of peptides from two separate classes are presented. Peptides in the first class are related to apamin, an 18 amino acid peptide toxin from honey bee venom. The ^{1}H NMR assignments and secondary structure determination of apamin were done previously. Quantitative NMR measurements and distance geometry calculations were done to calculate apamin's three dimensional structure. Peptides in the second class are 48 amino acid toxins from the sea anemone Radianthus paumotensis. The ^{1}H NMR assignments of toxin II were done previously. The ^{1}H NMR assignments of toxin III and the distance geometry calculations for both peptides are presented.

22717 (PB–90-131889/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on OSHA (Occupational Safety and Health Administration) guidelines on biotechnology to DOL (Department of Labor), by J. Donald Millar, August 1985.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1985. 6p. Available from NTIS, PC A02/MF A01.

The testimony reviewed the position of the National Institute for Occupational Safety and Health (NIOSH) concerning Occupational Safety and Health Administration (OSHA) proposed guidelines on biotechnology. In the guidelines OSHA stated that there was no evidence to warrant the issuance of new regulations specifically covering biohazards as workers would be adequately protected under already existing standards. NIOSH voices the feeling that it is not reasonable to expect that workers will be covered by provisions of a rule that has not been promulgated. It is also hard to predict how proposed changes in 29 CFR 1910.134 would affect the protection afforded to these workers. The second item concerns the use of Section 5(a) of the Occupational Safety and Health Act which states that each employer will provide a place of work free from recognized hazards, whereas many hazards present may not be recognized as such. Because research needs to indicate vast gaps in knowledge, NIOSH recommends that OSHA include, as part of their guidelines, requirements for increased industrial hygiene surveillance and medical monitoring.

22718 (PB–90-855669/XAB) **Transgenic plants and animals: Altered organisms from recombinant DNA technology. July 1982-July 1989 (Citations from the Life Sciences Collection data base). Report for July 1982-July 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 157p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the development and use of transgenic plants and animals. Topics include methods of induction of new genes and transgenetic expression in the organism, development of animal models of human diseases, and design of insect tolerant plants. Examples of transgenic organisms include mice, fish, chicken, pigs, rye, maize, tobacco, tomatoes, lettuce, and cotton. This information is of value for the increased production of food from animals by producing animal carcasses with reduced fat content. The information is also valuable for production of herbicide tolerant, virus resistant, and insect resistant crop plants, as well as the rapid production of transgenic plants with flowers and seeds. (Contains 383 citations fully indexed and including a title list.)

22719 (UCRL–102862) **Does DNA cytometry have a place in the clinical laboratory?.** Mayall, B. (Lawrence Livermore National Lab., CA (USA)); Waldman, F.; Chew, K.; Christov, K.; Goodson, W.; Ljung, B.M.; Smith, H.S. Lawrence Livermore National Lab., CA (USA). 24 Jan 1990. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911174–1: European Society for Analytical Cellular Pathology on advances in analytical cellular pathology, Schloss Elmau (Germany, F.R.), 12-17 Nov 1989). Order Number DE90007652. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are investigating the potential utility of cellular markers, including cellular proliferation and DNA cytometry, as independent diagnostic and prognostic markers in human breast cancer. However, as the clinical laboratory is responsible for providing physicians with data relevant to the patient, it is essential first to establish the validity of such markers before their use is recommended. Prospective validation is time-consuming and costly for tests of human malignancies, such as breast cancer, which may follow a lengthy and indolent course requiring patients to be followed for a decade or more before their clinical outcome is known. Therefore, retrospective studies on archival material are used whenever possible. Cell proliferation is recognized as an important diagnostic and prognostic marker for human breast cancer and a tritiated thymidine DNA labeling index greater than 5% is associated with a markedly less favorable outcome. Incorporation of bromodeoxyuridine (BrdUrd) into the DNA of S phase cells gives a similar labeling index. Unfortunately, paraffin-embedded archival material is rarely pre-labeled, and so DNA cytometry of either whole nuclei disaggregated from thick sections or partial nuclei in thin sections must be used as an indirect approach to estimate cellular proliferative activity. We are particularly interested in validating the DNA cytometry of thin sections and in relating the DNA histogram to in vivo BrdUrd labeling index, which is our standard for cellular proliferation. 6 refs., 1 fig.

22720 **Method of synthesizing double-stranded DNA molecules.** Jones, D. To National Institutes of Health, Bethesda, MD. USA Patent Application 7-432,993. 8 Nov 1989. 58p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This invention relates to a method in which the polymerase chain reaction (PCR) is used to generate products that when combined, denatured, and reannealed, form double-stranded DNA with discrete, cohesive, single-stranded ends. Such cohesive ends can be utilized in the formation of precise, directional DNA joints without dependence on enzyme-restriction sites. Furthermore, the placement of cohesive single strands on both ends of a DNA molecule permits a DNA strand or strands to be annealed to form circular DNA. These recombinant circles of DNA can be directly transfected into appropriate host cells. The method of generating recombinant circles upon reannealing PCR generated products simplifies DNA mutagenesis, recombination, and cloning.

5503 Cytology

Refer also to citation(s) 22711, 22719, 22745, 22750, 22764

22721 (PNL–6100-Pt.4, pp. 43) **Re-entry of starved plateau-phase Chinese hamster ovary cells into the replicative cycle.** Nelson, J.M.; Braby, L.A.; Metting, N.F.; Roesch, W.C. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Kinetic differences between fed and starved Chinese hamster ovary (CHO) cells have been demonstrated. These differences have been further characterized by subculturing 14-day-old plateau-phase cells and following them as they progressed through their first post-plateau-phase cycles. Deoxyribonucleic acid distributions were determined by flow-cytometric analysis of fixed trypsinized cells, stained by the acriflavine-Feulgen procedure. About 83% of the starved populations are found in G(1) phase. These cells re-enter the replicative cycle almost immediately, passing into S phase within 11 hours, and into G(2) phase within 18 hours. The remaining 17% initially comprise about 2/3 (≈ 10%) S-phase and 1/3 (≈ 7%) G(2)-phase cells. Both of these subpopulations progress rapidly through mitosis, apparently producing large numbers of DNA-deficient daughter cells as they do so. In contrast, fed cultures consist of a mixture of cycling and noncycling cells. The noncycling cells appear very similar to those observed in starved cultures. The cycling populations, however, progress peristaltically in an exceptionally synchronous manner, reflecting the intermittent feeding regimen. These nonexpanding, yet actively growing fed populations continue to produce nonviable daughters, which are later observed as Feulgen-positive debris.

5504 Genetics

Refer also to citation(s) 22714, 22718, 23206

5505 Metabolism

Refer also to citation(s) 21285, 21582, 22743

22722 (BNL–43714) **Dual photon absorptiometry: Validation of mineral and fat measurements.** Heymsfield, S.B. (Saint Luke's-Roosevelt Hospital Center, New York, NY (USA)); Wang, J.; Sulet, M.; Lichtman, S.; Pierson, R.N. Jr.; Kehayias, J.; Kamen, Y.; Dilmanian, F.A.; Lindsay, R. Brookhaven National Lab., Upton, NY (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract AC02-76CH00016. (CONF-8906269–6: 1989 international symposium on in vivo body composition studies, Toronto (Canada), 20-23 Jun 1989). Order Number DE90007675. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Photons passing through human tissue undergo attenuation in relation to the specific chemical substances with which they interact. By selecting two appropriate photon energies and recording their attenuation, the investigator can solve simultaneous equations that subdivide body mass into two components: soft tissue and bone mineral ash. The aim of this paper is to describe and to validate the estimates of body composition derived by dual photon systems. The initial studies largely involved dual photon absorptiometers, although the discussion will also include the more recently developed dual energy x-ray absorptiometers. 13 refs., 7 figs., 4 tabs.

22723 **Activation of formylmethanofurna synthesis in cell extracts of Methanobacterium thermoautotrophicum.** Bobik, T.A. (Univ. of Illinois, Urbana (USA)); Wolfe, R.S. *Journal of Bacteriology (USA),* 171(3): 1423-1427 (Mar 1989).

In cell extracts of Methanobacterium thermoautotrophicum, formylmethanofuran (formyl-MFR) synthesis (an essential CO_2 fixation reaction that is an early step in CO_2 reduction to methane) is subject to a complex activation that involves a heterodisulfide of coenzyme M and N-(7-mercaptoheptanoyl)threonine O^3-phosphate (CoM-S-S-HTP). In this paper we report that titanium(III) citrate, a low-potential reducing agent, stimulated CO_2 reduction to methane and activated formyl-MFR synthesis in cell extracts. Titanium(III) citrate functioned as the sole source of electrons for formyl-MFR synthesis and enabled this reaction to occur independently of CoM-S-S-HTP. In addition, CoM-S-S-HTP was found to activate an unknown electron carrier that reduced metronidazole. The activation of formyl-MFR synthesis by CoM-S-S-HTP may involve the activation of a low-potential electron carrier.

5506 Medicine

Refer also to citation(s) 22451, 22459, 22754

22724 (DOE/ER/60460–4) **Studies in technetium chemistry, Project 1: Evaluation of technetium acetylacetonates as potential cerebral blood flow agents, Project 2: Administrative data, August 1, 1988–August 30, 1989.** Jones, A.G. (Harvard Medical School, Boston, MA (USA)); Packard, A.B.; Treves, S.; Davison, A. Massachusetts Inst. of Tech., Cambridge, MA (USA). [1990]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60460. Order Number DE90008420. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Although the emphasis in our original submission was on N_2S_2 and N_3S coordinating ligands in technetium(V), we have now broadened the chemistry studies into areas that encompass new systems that allow the generation of neutral complexes. This change was based upon developments that have taken place in our basic chemistry studies that could bear on one of the original aims of this work, i.e., the design of complexes designed to penetrate cellular membranes and to remain trapped in target tissues. Among these topics are oxotechnetium(V) complexes containing amine and alcoholate ligands, coordination compounds containing the alternative technetium(V) nitrido core and the synthesis at macroscopic levels of a tetradentate "umbrella" ligand that successfully binds the metal. Basic studies with the original bisamide-bisthiol ligand system have continued with the identification of the products formed when aqueous solutions of the complex $[TcO(ema)]^-$ are acidified. This material is isolatable as yellow/brown crystals when HCl is added to the tetraphenylarsonium salt of the complex synthesized according to published procedures. Elemental analysis, FAB(+) mass spectrometry and ^1H NMR results were consistent with the formulation TcO(ema)H. Infrared spectra showed a dramatic shift in the Tc = O stretch to 966 cm^{-1}, as distinct from 945 cm^{-1} in the original complex.

22725 (LBL–27948) **Software quality assurance and software safety in the Biomed Control System.** Singh, R.P.; Chu, W.T.; Ludewigt, B.A.; Marks, K.M.; Nyman, M.A.; Renner, T.R.; Stradtner, R. Lawrence Berkeley Lab., CA (USA). 31 Oct 1989. 16p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract AC03-76SF00098. Order Number DE90008072. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Biomed Control System is a hardware/software system used for the delivery, measurement and monitoring of heavy-ion beams in the patient treatment and biology experiment rooms in the Bevalac at the Lawrence Berkeley Laboratory (LBL). This paper describes some aspects of this system including historical background philosophy, configuration management, hardware features that facilitate software testing, software testing procedures, the release of new software quality assurance, safety and operator monitoring. 3 refs.

22726 (LBL–28249) **Clinical results of stereotactic helium-ion radiosurgery of the pituitary gland at Lawrence Berkeley**

Laboratory. Levy, R.P.; Fabrikant, J.I.; Lyman, J.T.; Frankel, K.A.; Phillips, M.H.; Lawrence, J.H.; Tobias, C.A. Lawrence Berkeley Lab., CA (USA). Dec 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8906298–1: International workshop on proton and narrow photon beam therapy, Oulu (Finland), 8-10 Jun 1989). Order Number DE90008465. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The first therapeutic clinical trial using accelerated heavy-charged particles in humans was performed at Lawrence Berkeley Laboratory (LBL) for the treatment of various endocrine and metabolic disorders of the pituitary gland, and as suppressive therapy for adenohypophyseal hormone-responsive carcinomas and diabetic retinopathy. In acromegaly, Cushing's disease, Nelson's syndrome and prolactin-secreting tumors, the therapeutic goal in the 433 patients treated has been to destroy or inhibit the growth of the pituitary tumor and control hormonal hypersecretion, while preserving a functional rim of tissue with normal hormone-secreting capacity, and minimizing neurologic injury. An additional group of 34 patients was treated for nonsecreting chromophobe adenomas. This paper discusses the methods and results of stereotactic helium-ion radiosurgery of the pituitary gland at Lawrence Berkeley Laboratory. 11 refs.

22727 (LBL–28250) **Heavy charged-particle beams for stereotactic radiosurgery.** Lyman, J.; Phillips, M.; Frankel, K.; Fabrikant, J.; Levy, R. Lawrence Berkeley Lab., CA (USA). Dec 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8906298–2: International workshop on proton and narrow photon beam therapy, Oulu (Finland), 8-10 Jun 1989). Order Number DE90008466. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A number of characteristics of the interactions of charged particles with matter make them well-suited for stereotactic radiosurgery. The depth-dose distribution is characterized by the Bragg ionization peak. The Bragg Peak is too narrow for the treatment of most targets of interest however, the range of the beam can be modulated to move the Bragg peak from a single entry direction, to different depths to produce a high-dose region at the desired depth. The range of the beam along different rays through the target can be differentially modulated to conform the distal portion of the high-dose region to the distal surface of the target volume. This document discusses an advanced beam delivery system, under development at the Lawrence Berkeley Laboratory, will make possible the conformation of the proximal high-dose region to the proximal surface of the target volume. Included are the methods, materials, discussion and conclusions. 14 refs., 1 fig., 1 tab.

22728 (LBL–28251) **Effects of target size on the comparison of photon and charged particle dose distributions.** Phillips, M.H.; Frankel, K.A.; Tjoa, T.; Lyman, J.T.; Fabrikant, J.I.; Levy, R.P. Lawrence Berkeley Lab., CA (USA). Dec 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8909244–2: International heavy particle therapy workshop, Villigen (Switzerland), 18-20 Sep 1989). Order Number DE90007777. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The work presented here is part of an ongoing project to quantify and evaluate the differences in the use of different radiation types and irradiation geometries in radiosurgery. We are examining dose distributions for photons using the "Gamma Knife" and the linear accelerator arc methods, as well as different species of charged particles from protons to neon ions. A number of different factors need to be studied to accurately compare the different modalities such as target size, shape and location, the irradiation geometry, and biological response. This presentation focuses on target size, which has a large effect on the dose distributions in normal tissue surrounding the lesion. This work concentrates on dose distributions found in radiosurgery, as opposed to those usually found in radiotherapy. 5 refs., 2 figs.

22729 (LBL–28253) **Clinical results of stereotactic helium-ion radiosurgery of the pituitary gland at Lawrence Berkeley Laboratory.** Levy, R.P.; Fabrikant, J.I.; Lyman, J.T.; Frankel, K.A.; Phillips, M.H.; Lawrence, J.H.; Tobias, C.A. Lawrence Berkeley Lab., CA (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8905227–6: International conference on radiosurgery a neurosurgical approach to intracranial lesions, Charlottesville, VA (USA), 1-5 May 1989). Order Number DE90008467. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The first therapeutic clinical trial using accelerated heavy-charged particles in humans was performed for the treatment of various endocrine and metabolic disorders of the pituitary gland, and as suppressive therapy for adenohypophyseal hormone-responsive carcinomas and diabetic retinopathy. Since then, over 800 patients have received stereotactically-directed plateau-beam heavy-charged particle pituitary irradiation at this institution. In acromegaly, Cushing's disease, Nelson's syndrome and prolactin-secreting tumors, the therapeutic goal in the 433 patients treated has been to destroy or inhibit the growth of the pituitary tumor and control hormonal hypersecretion, while preserving a functional rim of tissue with normal hormone-secreting capacity, and minimizing neurologic injury. An additional group of 34 patients was treated for nonsecreting chromophobe adenomas. This paper discusses the methods and results of these treatments. 11 refs.

22730 (LBL–28254) **Clinical results of stereotactic heavy-charged-particle radiosurgery for intracranial angiographically occult vascular malformations.** Levy, R.P.; Fabrikant, J.I.; Phillips, M.H.; Frankel, K.A.; Steinberg, G.K.; Marks, M.P.; DeLaPaz, R.L.; Chuang, F.Y.S.; Lyman, J.T. Lawrence Berkeley Lab., CA (USA). Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8905227–5: International conference on radiosurgery a neurosurgical approach to intracranial lesions, Charlottesville, VA (USA), 1-5 May 1989). Order Number DE90007756. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Angiographically occult vascular malformations (AOVMs) of the brain have been recognized for many years to cause neurologic morbidity and mortality. They generally become symptomatic due to intracranial hemorrhage, focal mass effect, seizures or headaches. The true incidence of AOVMs is unknown, but autopsy studies suggest that they are more common than high-flow angiographically demonstrable arteriovenous malformations (AVMs). We have developed stereotactic heavy-charged-particle Bragg peak radiosurgery for the treatment of inoperable intracranial vascular malformations, using the helium ion beams at the Lawrence Berkeley Laboratory 184-inch Synchrocyclotron and Bevatron. This report describes the protocol for patient selection, radiosurgical treatment planning method, clinical and neuroradiologic results and complications encountered, and discusses the strengths and limitations of the method. 10 refs., 1 fig.

22731 (LBL–28255) **Clinical-radiological evaluation of sequelae of stereotactic radiosurgery for intracranial arteriovenous malformations.** Levy, R.P.; Fabrikant, J.I.; Frankel, K.A.; Phillips, M.H.; Steinberg, G.K.; Marks, M.P.; DeLaPaz, R.L.; Chuang, F.Y.S. Lawrence Berkeley Lab., CA (USA). Dec 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8905227–7: International conference on radiosurgery a neurosurgical approach to intracranial lesions, Charlottesville, VA (USA), 1-5 May 1989). Order Number DE90008496. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Stereotactic heavy-charged-particle Bragg peak radiosurgery has been used to treat 322 patients with surgically-inaccessible intracranial vascular malformations. (The clinical results of this method for the treatment of angiographically demonstrable arteriovenous malformations (AVMs) and angiographically occult vascular malformations (AOVMs) of the brain are described in separate reports of this symposium). The great majority of patients have had an uneventful post-treatment course with satisfactory health outcomes. However, several categories of delayed sequelae of stereotactic radiosurgery have been identified, involving the vascular structures essential for the integrity of the brain tissue and the brain parenchyma directly. These categories reflect both reaction to injury and to alterations in regional hemodynamic status, and include vasogenic edema, occlusion of functional vasculature, radiation necrosis, and local or remote effects on cerebral arterial aneurysms. 10 refs., 7 figs., 1 tab.

22732 (PB–90-131624/XAB) **Follow-up study of persons who had iodine-131 and other diagnostic procedures during childhood and adolescence.** Hamilton, P.M.; Chiacchierini, R.P.;

Kaczmarek, R.G. Food and Drug Administration, Rockville, MD (USA). Center for Devices and Radiological Health. Aug 1989. 46p. (DHHS/PUB/FDA–89-8276). Available from NTIS, PC A03/MF A01.

A prospective study of 3,503 children and adolescents who received diagnostic doses of iodine-131 was conducted to evaluate the risk of radiation-induced thyroid neoplasia. The exposed group was followed for a total of 93,442 person-years. Thyroid doses received by the exposed group ranged from less than 10 rads to slightly more than 2,000 rads. The majority received less than 100 rads. A group of 2,594 children and adolescents who were not exposed to radioactive iodine comprised the control group for the study. Members of the control group were followed for a total of 66,797 person-years. An elevated risk of malignant thyroid tumors was observed in the exposed group. An increased risk of benign thyroid conditions was also noted in the exposed group. The results described above failed to fulfill the requirements for statistical significance because of the small number of cases but are suggestive of a radiation effect.

5507 Microbiology

Refer also to citation(s) 21125, 21157, 21285

5509 Pathology

Refer also to citation(s) 22772

22733 (PB–90-130139/XAB) **Byssinosis and small airways disease: Terminal progress report.** Bradford, J.M. Emory Univ., Atlanta, GA (USA). 1989. 37p. Available from NTIS, PC A03/MF A01.

In a study of byssinosis and small-airway disease, pulmonary-function measurements including helium and oxygen flow volume curves were made on 470 cotton mill employees exposed to various dust levels. The employees in these cotton mills had been screened previously for pulmonary abnormalities, and some employees had moved to work areas with lower dust levels. Results showed that there was no significant increase in bronchitis or byssinosis in the dust areas nor were there any significant decreases in the percentages of normal forced vital capacity (PFVC) or forced expiratory volume in 1 second (PFEV1) in the dusty areas. These results differ from those reported from mills in which no previous pulmonary testing had been conducted. A strong smoking/tenure/dust exposure interaction on PFVC and PFEV1 was found, with the long-tenured, high-dust-exposure, smokers having the lowest PFVC and PFEV1. There was no significant increase in small airways abnormalities with increased dust and smoking, but the mean change in the density dependence ratio is too small to have clinical significance.

5520 Public Health

Refer also to citation(s) 21155, 21180, 21181, 21895, 21896, 22514, 22515, 22516, 22517, 22518, 22523, 22717, 22733, 22761

22734 (PB–90-133125/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on occupational diseases before the Senate Committee on Labor and Human Resources, by Anthony Robbins, April 2, 1979.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 2 Apr 1979. 18p. Available from NTIS, PC A03/MF A01.

The testimony considered National Institute for Occupational Safety and Health (NIOSH) research efforts designed to determine whether illness and injury are job-related. Since 1970 when the Occupational Safety and Health Act was passed, awareness has increased that chemical and physical agents play a role in the etiology of disease. A survey conducted in 1972 to 1974 indicated that one in four American workers was potentially exposed either full or part time to hazardous substances regulated by OSHA. Often illnesses were improperly diagnosed, resulting in difficulties of accurately determining the magnitude of the problem. Most of the past research has centered on the effect of exposure to one agent at a time, but most occupational exposures were to multiple agents, simultaneously. A suggested approach to developing occupational-disease standards involved the determination of whether the workers have symptoms compatible with the effects of occupational exposure and whether the workers had received sufficient exposure to cause the disease. Specific efforts that have been directed toward the specific substances and advancements which have thus been made were detailed for asbestos, cotton dust exposure, toluene-diisocyanate, and dibromochloropropane. Brief mention was made of a respiratory disease report, criteria for diagnosing occupational disease, and strategies for prevention.

5530 Agriculture and Food Technology

Refer also to citation(s) 22584, 22743

22735 (IAEA-R–5462-F) **Development of ^{99m}Tc-labelled the d,1-diastereoisomer of HM-PAO for cerebral blood flow imaging: Final report for the period 15 December 1988 - 22 July 1989.** Lun Xiao. Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy; International Atomic Energy Agency, Vienna (Austria). Oct 1989. 35p. (CONF-8709362–: 4. working meeting on radiation interaction, Leipzig (German Democratic Republic), 21-25 Sep 1987). Order Number DE90617634. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The d,1-diastereoisomer of hexamethyl propyleneamine oxime (HM-PAO) was selected as the preferred ligand for Tc-99m as a radiotracer for cerebral perfusion imaging. Further improvement of the synthesis and isolation method of HM-PAO resulted in pure d,1-HM-PAO and pure meso-HM-PAO. The neutral, lipophilic Tc-99m complexes of d,1-HM-PAO and meso-HM-PAO were formed in high yield by stannous reduction of Mo-99/Tc-99m generator eluate, respectively. Two minutes following i.v. administration of Tc-99m-d,1-HM-PAO in mice, 2.24% of the injected dose appears in the brain. Little washout of the tracer is observed up to 24-hour post injection. Two minutes following i.v. administration of Tc-99m-meso-HM-PAO in mice, 1.9% of the injected dose appears in the brain. The radioactivity of Tc-99m-meso-HM-PAO declined faster than that of Tc-99m-d,1-HM-PAO did in the brain up to 24-hour post injection. 12 refs, 5 figs, 5 tabs.

22736 (PB–90-855768/XAB) **Nuclear magnetic resonance: Applications in the food industry. January 1972-December 1989 (Citations from the Food Science and Technology Abstracts data base). Report for January 1972-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 160p. Available from NTISPC N01/MF N01.

Supersedes PB–88-863410.

This bibliography contains citations concerning the applications of nuclear magnetic resonance (NMR) imaging in the food industry. Analysis of flavor compounds, moisture content, fat crystallization, protein soluability, pigments, and compounds that preserve foods are discussed. Chemical changes in processed foods and biological processes such as plant growth and respiration are also studied. (This updated bibliography contains 367 citations, 48 of which are new entries to the previous edition.)

22737 (VR–88-05) **Reports from the RIVM 1987.** Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. 326p. (In Dutch). Order Number DE90619668. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

In this report the progress and developments of the departments within the headsectors; Microbiology and Immunology, Farmacology and Toxicology, Chemistry and Physics, of the Dutch National Institute for Environment Hygiene and Public Health (RIVM) over the year 1987, and a collection of separate research papers are presented. One of these is in INIS scope presenting a radiation-burden model for the contamination via the air-grass-cow-milk route. (H.W.). refs.; figs.; tabs.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 21485, 21486, 21516, 21517, 21521, 21543, 21544, 21545, 21546, 21627, 22201, 22493, 22544, 22549, 22581, 22726, 22728, 22730, 22731, 22737, 22863, 22950, 22952, 22953

22738 (AD-A-214519/1/XAB) **Benzamide prevention of ultraviolet radiation-induced transformation as measured by anchorage-independent growth and absence of correlation with thymidine dimer formation and DNA repair.** Milo, G.E.; d'Ambrosio, S.; Kun, E. San Francisco State Univ., CA (USA). 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Teratogenesis, Carcinogenesis, and Mutagenesis, Vol. 9, 167-176(1989).

Synchronized human fibroblasts were exposed in early S phase to increasing doses of ultraviolet (UV) irradiation in the presence and absence of an antitransforming drug, benzamide. Cellular survival, initial thymidine dimer formation and its repair, and cellular phenotypic transformation were simultaneously monitored in the presence and absence of 1 mM externally added benzamide that reaches 8 to 15 microns intracellular levels. Cellular transformation as measured by an expression of anchorage-independent growth was inhibited by nontoxic doses of benzamide. Antitransforming action of benzamide is confined to low intracellular drug concentrations, which in the case of benzamide is in the 4-9 micons range. Because of the lack of effect of benzamide of the formation of UV-induced thymidine dimers and the specific repair of these dimers, these results suggest that the processes of thymidine dimer formation and its repair are not involved in the mode of action of benzamide that influences the expression of a transformed phenotype with low malignant vigor.

22739 (AD-A-214524/1/XAB) **Survival after total-body irradiation. 1. Effects of partial small bowel shielding.** Vigneulle, R.M.; Vriesendorp, H.M.; Taylor, P.; Burns, W.; Pelkey, T. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 13p. (AFRRI-SR-89-39). Available from NTIS, PC A03/MF A01.

Pub. in Radiation Research, Vol. 119, 313-324(1989).

The small intestine of the rat was shielded during total-body irradiation (TBI) to evaluate the effects of radiation dose and length of intestine shielded on survival. Sprague-Dawley rats were anesthetized in groups of 10. Using aseptic surgical procedures 80, 40, 20, or 10 cm, or none of the proximal or distal small intestine were temporarily exteriorized and shielded during irradiation with photons from an 18-MeV linear accelerator. Less than 17% of the dose was delivered to the shielded intestines. In unshielded animals deaths occurred from Days 4 to 6 with 13, 15, or 17 Gy and from Days 8 to 30 with 9, 11, and 12 Gy. However, in all animals exposed to 15 Gy with all or part of the small intestine shielded, survival was increased to between 5 and 9 days. Shielding of the distal small intestine. The previously identified target of radiation damage in the small intestine is the crypt stem cell. In this study, the analysis of histological specimens of shielded and irradiated small intestine suggested that humoral factors also influence intestinal histology and survival after irradiation. These humoral factors are thought to originate from the irradiated body tissues, the shielded proximal intestine, and the shielded distal intestine. Further studies are required to identify these factors and to determine their mode of action and their therapeutic potential after radiation damage to the small intestine.

22740 (AD-A-214558/9/XAB) **Effect of ultraviolet radiation on the energy metabolism of the corneal epithelium of the rabbit. Final report.** Lattimore, M.R. Army Aeromedical Research Lab., Fort Rucker, AL (USA). Sep 1989. 14p. (USAARL-89-26). Available from NTIS, PC A03/MF A01.

Pub. in Photochemistry and Photobiology, Vol. 49, No. 2, 175-180(1989).

The present research was directed at quantifying possible alterations in corneal epithelial metabolic activity secondary to in-vivo exposure to ultraviolet radiation (UVR). Microfluorometric energy metabolite assays on microgram (ug) sized, freeze-dried tissue samples were used as an in vitro means of assessing overall metabolic activity in the epithelium of control rabbit corneas and in the epithelium of UVR-exposed rabbit corneas 2 min after discontinuation of exposure. The specific assays were for glucose, glycogen, adenosine triphosphate (ATP), and phosphocreatine (PCr). The radiant exposures were kept constant at 0.05 J cm-2 for all UVR wavelengths utilized (290, 300, 310 and 360 nm). Experimental UVR exposure conditions served to increase epithelial glucose and glycogen concentrations. Although the epithelial ATP concentrations were unchanged, the epithelial PCr concentrations (a high energy phosphate bond reservoir) decreased as a result of UVR exposure. Overall, the data demonstrate a decrease in corneal epithelial metabolic activity, which may be wavelength-dependent, as a result of UVR exposure. It is suggested that immediate metabolic stress can be responsible for the pattern of epithelial cell loss seen in photokeratitis.

22741 (AD-A-214960/7/XAB) **AFRRI (Armed Forces Radiobiology Research Institute) reports, July, August, September 1989. Technical report.** Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). Nov 1989. 147p. Available from NTIS, PC A07/MF A01.

Includes rept. nos. AFRRI-SR89-26 through AFRRI-SR89-39 and AFRRI-TR89-1.

This volume contains AFRRI Scientific Reports SR 89-26 through SR89-39 and Technical Report TR89-1 for Jul-Sep 1989. Partial contents include: Induction of marrow hypoxia by radioprotective agents; Cell-cycle radiation response: Role of intracellular factors; Characteristics of radiation-induced performance changes in bar-press avoidance with and without a preshock warning cue; Norepinephrine-induced phosphorylation of a 25 kd phosphoprotein in rat aorta is altered in intraperitoneal sepsis; Quantitative measurement of radiation-induced base products in DNA using gas chromatography-mass spectrometry; Tropism of canine neutrophils to xanthine oxidase; Effects of acute sublethal gamma radiation exposure on aggressive behavior in male mice: A dose-response study; Progressive behavioral changes during the maturation of rats with early radiation-induced hypoplasia of fascia dentata granule cells; Stomach nodules in pigeons; An assessment of the behavioral toxicity of high-energy iron particles compared to other qualities of radiation; L-leucyl-L-leucine methyl ester treatment of canine marrow and peripheral blood cells; Localization of cyclooxygenase and prostaglandin E2 in the secretory granule of the mast cell; Radioprotection of mice with interleukin-1: Relationship to the number of spleen colony-forming units; Survival after total-body irradiation. I. Effects of partial small-bowel shielding; Laboratory x-ray irradiator for cellular radiobiology research studies: Dosimetry report.

22742 (AERE-R-13220) **The distribution and uptake of rare-earth elements in the food chain and their use as analogues for the transuranic elements: A literature review.** Dalgarno, B.G. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. Jul 1988. 38p. Available from H.M. Stationery Office, London, price Pound 10.00. Available from H.M. Stationery Office, London, price Pound 10.00.

A literature review has been undertaken into the distribution and uptake of rare-earth elements in the food chain and their use as analogues for the transuranic elements. Much of the value derived from using rare-earth elements in 'potential analogue' experiments is based on the effective invariance of the stable oxidation state in the environment (+3). With regard to the uptake by plants, it may be concluded that the complete series of elements behaves as a continuous function of the ionic radius. Consequently, it may be inferred that the plant uptake of other ions with similar physicochemical properties such as the transuranic elements, would also be determined by the ionic charge and radius. A primary aim has been to determine the abundance of the rare-earth elements in the environment so that an assessment may be made as to the feasibility of their use in the study of human-uptake of transuranic elements. Needs have been identified for more information on the concentration of rare earth elements in foodstuffs and in human biological fluids including blood, urine and milk. (author).

22743 (BMU–1989-217) **Transfer of Cs-137 from food into milk of breast-feeding women.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Gall, M.; Mahler, S.; Wirth, E. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1988. 14p. (In German). Contract BMU St.Sch. 1037. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Between May 1987 and May 1988 a duplicate of the food taken in as well as a specimen of the milk of 8 nursing mothers was daily collected during 3-4 weeks and the Cs 137 activity was measured. Moreover the mothers' whole-body activity was measured once during the collection period. The measured values show that apart from the direct transfer of Cs 137 from the food taken in into the breast milk a transfer of cellular Cs 137 from the mother's body into the breast milk is also taking place. During this process about 12% of the mother's Cs 137 activity concentration and about 19% of the Cs 137 activity daily taken in with the food are transferred into one liter of breast milk. (orig.).

22744 (BMVg-FBWM–89-18) **Investigations into the suppression of the nonspecific defence system by ionising radiation.** Pawlas, S.; Mayr, A. Muenchen Univ. (Germany, F.R.). Inst. fuer Medizinische Mikrobiologie, Infektions- und Seuchenmedizin; Bundesministerium der Verteidigung, Bonn (Germany, F.R.). 10 Mar 1988. 61p. (In German). Contract InSan I 0585-V-4387. Available from Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw). Available from Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw).

While nonspecific mechanisms such as activity of NK-cells and induction of interferon were not suppressed after inhomogenous total body irradiation of mice with 1,95/3,90 and 5,85 Gy, an extreme decrease in spleen weight, in the yield of lymphocytes from the spleen and their response to mitogenic stimulation was observed. The general effect of these influences on the interaction of the numerous factors and mechanisms of the nonspecific part of defence was investigated in an antigen-challenge model with stomatitis vesicularis virus in babymice after total body irradiation (3,90 Gy) of the babymice or their pregnant mothers. Irradiation of the babymice showed no significant influence on mortality after infection, while irradiation of their pregnant mothers caused an astonishing decrease of mortality compared to that of animals with no exposure to X-rays. In the same model it was demonstrated that the protective effect of the paramunity inducer 'PIND ORF' on mortality after infection was impaired neither by irradiation of the babymice nor by irradiating their pregnant mothers. The antigen-challenge model Aujeszky virus/adult mouse (exposure to 1,95/3,90 and 5,85 Gy) proved that the influence of irradiation not only depends on the dose but also on the moment of the exposure. The behaviour of opportunistic germs (P. multocida, Ps. aeruginosa) and vaccination viruses (Vaccinia virus, strain Elstree and MVA) in mice remained unchanged after irradiation with 1,95/3,90 Gy, whereas irradiation with 5,85 Gy caused a varying increase of mortality after infection with P. multocida and Ps. aeruginosa. (orig./MG) With 5 refs., 11 tabs.

22745 (BNL–43715) **Is natural background or radiation from nuclear power plants leukemogenic?.** Cronkite, E.P. Brookhaven National Lab., Upton, NY (USA). [1989]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8910360–1: 15. annual Frederick Stohlman Jr., M.D. memorial symposium, Cambridge, MA (USA), 15-20 Oct 1989). Order Number DE90006531. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The objective in this review is to provide some facts about normal hemopoietic cell proliferation relevant to leukemogenesis, physical, chemical, and biological facts about radiation effects with the hope that each person will be able to decide for themselves whether background radiation or emissions from nuclear power plants and facilities significantly add to the spontaneous leukemia incidence. 23 refs., 1 tab.

22746 (CEA-R–5485) **^{60}Co accumulation by scenedesnus obliquus. Mechanism of uptake and relative contribution of radionuclide adsorption and absorption.** Nucho, R.; Baudin, J.P. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Jun 1989. 30p. (In French). Order Number DE90756426. Available from NTIS (US Sales Only), PC A03/MF A01.

In this paper are presented the results of various ^{60}Co accumulation and depuration experiments, carried out to assess the respective contributions of passive and active processes in the radionuclide uptake by Scenedesmus obliquus. The experiments were conduced on living illuminated cells, living cells maintained in darkness and dead cells. Exposure study shows that living illuminated cells and dead cells incorporated the same amount of available ^{60}Co, in the order of 65%. In contrast, the radionuclide uptake by cells in darkness was very lower. Depuration experiments show that radiocobalt release by living illuminated cells and dead cells is an exponential process including two phases. The first, during which the decrease of the radioactivity was about 80%, corresponds to elimination of the ^{60}Co adsorbed on the cell walls. During the second phase, the slight decrease of the radioactivity results from the intracellular ^{60}Co desorption. The addition of EDTA in the depuration culture medium results in an almost instantaneous loss of 80% of the accumulated radionuclide. The results clearly indicate that ^{60}Co uptake is mainly a passive phenomenon, since adsorption accounts for 80% of the accumulation and passive diffusion for about 10%. Metabolic assimilation contributes for a weak part.

22747 (CEGB-RD-B–6122/R89) **Skin carcinogenesis following uniform and non-uniform β irradiation.** Charles, M.W. (Saint Bartholomew's Hospital, London (UK)); Williams, J.P.; Coggle, J.E. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Jan 1989. 19p. Order Number DE90619589. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Where workers or the general public may be exposed to ionising radiation, the irradiation is rarely uniform. The risk figures and dose limits recommended by the International Commission on Radiological Protection (ICRP) are based largely on clinical and epidemiological studies of reasonably uniform irradiated organs. The paucity of clinical or experimental data for highly non-uniform exposures has prevented the ICRP from providing adequate recommendations. This weakness has led on a number of occasions to the postulate that highly non-uniform exposures of organs could be 100,000 times more carcinogenic than ICRP risk figures would predict. This so-called "hot-particle hypothesis" found little support among reputable radiobiologists, but could not be clearly and definitively refuted on the basis of experiment. An experiment, based on skin tumour induction in mouse skin, is described which was developed to test the hypothesis. The skin of 1200 SAS/4 male mice has been exposed to a range of uniform and non-uniform sources of the β emitter ^{170}Tm ($E_{max} \approx 1$ MeV). Non-uniform exposures were produced using arrays of 32 or 8 2-mm diameter sources distributed over the same 8-cm^2 area as a uniform control source. Average skin doses varied from 2-100 Gy. The results for the non-uniform sources show a 30% reduction in tumour incidence by the 32-point array at the lower mean doses compared with the response from uniform sources. The eight-point array showed an order-of-magnitude reduction in tumour incidence compared to uniform irradiation at low doses. These results, in direct contradiction to the "hot particle hypothesis", indicate that non-uniform exposures produce significantly fewer tumours than uniform exposures. (author).

22748 (CONF-900224–4) **Whole body counting of radon daughters.** Schlenker, R.A.; Essling, M.A.; Stebbings, J.H.; Lucas, H.F. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. Department of Health and Human Services. DOE Contract W-31109-ENG-38. From International symposium on radon and radon reduction technology; Atlanta, GA (USA); 19-23 Feb 1990. Order Number DE90007790. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper reports the initial work in a series of experiments involving experimental exposure to radon and radon daughter products in an exposure chamber. Five adult males were exposed for

one hour to radon and radon daughter products in an exposure chamber and were subsequently measured for radon daughter product activity in the chest region by whole body counting methods. About half of the deposited activity was associated with internal deposition and half with external deposition on clothing, skin and hair. A substantial contribution was made to the counting rate from deposits on under as well as outer clothing. A strong but statistically non significant correlation was found between internal and external deposition indicating that total activity provides an index of internal deposition. 2 refs., 3 figs., 4 tabs.

22749 (CONF-8811313–1) **Implementing a new TLD system.** Rhea, T.A. Oak Ridge National Lab., TN (USA). [1988]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 2. annual Harshaw TLD user's group meeting; Myrtle Beach, SC (USA); 13-16 Nov 1988. Order Number DE90007656. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Martin Marietta Energy Systems will soon be issuing new personnel dosimeters at four of their five Department of Energy (DOE) facilities, The Piketon, Ohio uranium enrichment facility is not included in this dosimetry upgrade program. This talk will focus on the ORNL perspective of this program, especially the new beta-gamma dosimeter. Neutron dosimetry will be discussed briefly. The objective of this upgrade is to put in place a state-of-the-art personnel dosimetry system and to meet the recent DOE Laboratory Accreditation Program performance criteria. Processing such a large number of dosimeters will require stringent quality controls. Approximately 18,000 beta-gamma dosimeters are scheduled for issue in January 1989. 15 figs.

22750 (CONF-8909210–8) **Calculations of Auger-cascade-induced reactions with DNA in aqueous solution.** Hamm, R.N. (Oak Ridge National Lab., TN (USA)); Wright, H.A.; Turner, J.E.; Howell, R.W.; Rao, D.V.; Sastry, K.S.R. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989. Order Number DE90008747. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The biological effects of radionuclides incorporated into mammalian cells are of considerable interest for radiation biology and radiation protection. Simulation of the nuclear and atomic events associated with the decay of several Auger-electron-emitting radionuclides was accomplished using Monte Carlo calculational techniques. Calculations of the energies of Auger electrons produced from a number of decays have been performed for the radionuclides Pt-195m, Pt-193m, I-125, In-111, and Fe-55. The Monte Carlo radiation transport code OREC (8, 11-13) has been used to transport the electrons produced during the Auger cascades through liquid water surrounding the decay site and to calculate the physical and chemical interactions produced. In order to estimate the interactions that might be produced with a DNA molecule, a very simple model has been assumed. A segment of double-stranded DNA is represented as a right circular cylinder of radius 1 nm with "sugar" and "base" reactive sites alternating along two helical strands on the surface. For the purposes of this paper two types of interactions with the DNA are considered. During the charged-particle transport the DNA cylinder is treated as though it were water, and if an inelastic energy loss event occurs within the cylinder it is considered to represent a "direct" physical event. An "indirect" chemical event is considered to result when a reactive chemical species interacts with a "sugar" or "base" site on the DNA. Although no attempt is made to identify the consequences of these direct or indirect events, it is interesting to compare the relative numbers of such events for various types of radiation. 13 refs., 4 figs.

22751 (DOE/EH–0128) **Radiation exposures for DOE and DOE contractor employees, 1987: Twentieth annual report.** Pacific Northwest Lab., Richland, WA (USA). Oct 1989. 55p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90006342. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report is one of series of annual reports provided by the US Department of Energy (DOE) summarizing occupational radiation exposures received by DOE and DOE contractor employees. These reports provide an overview of radiation exposures received each year, as well as identification of trends in exposures being experienced over the years. 5 figs., 30 tabs.

22752 (INIS-mf–11551) **The influence of fractionation and repair kinetics on radiation tolerance: Studies on rat lung and kidney.** Rongen, E. van. Amsterdam Univ. (Netherlands). 8 Jun 1989. 159p. Order Number DE90706043. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The effect of irradiation of biological tissues is described as the sum of a linear and a quadratic function of the radiation dose, in which α and β and β are denoted as the coefficients of the linear and quadratic terms respectively. The rate of repair of radiation damage is expressed by the half-life time T 1/2. The purpose of the study described in the thesis was to determine the α/β and T 1/2 values for early and late effects in lungs and kidneys of the rat. Rats have been irradiated upon one or both organs in various numbers of fractions, which have been administered with long or short time intervals in order to obtain respectively complete and incomplete repair. From the results, values for α/β and T 1/2 could be obtained by means of computer codes. The results of this investigation indicate that for the lung differences exist in α/β for early and late effects. The α/β value for early effects being larger:3.5 Gy, than the one for late effects: 2.3 Gy. The values for T 1/2 were respectively 1.0 hour for early and 1.1 hour for late effects. The kidney experiments resulted in equal α/β values for early and late effects: respectively, 1.7 and 1.8 Gy. The T 1/2 values, however, differed being respectively, 1.6 hour and 2.1 hour. Also the influence of the fraction dose upon the α/β and T 1/2 values was investigated. For the lung such effects have not been found. In the kidney only between 20 and 40 weeks after the irradiation differences were observed, which disappeared after this period. The results of this investigation indicate that, in radiotherapy of tumors where lungs and kidneys are contained in the radiation field a scheme following which a large number of small fractions are administered, would give therapeutical advantage with respect to standard therapy. (HW) 240 refs., 38 figs., 37 tabs.

22753 (LA–11740-MS) **High-energy neutron dosimetry at the Clinton P. Anderson Meson Physics Facility.** Mallett, M.W.; Vasilik, D.G.; Littlejohn, G.J.; Cortez, J.R. Los Alamos National Lab., NM (USA). Jan 1990. 19p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90006346. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Neutron energy spectrum measurements performed at the Clinton P. Anderson Meson Physics Facility indicated potential areas for high energy neutron exposure to personnel. The low sensitivity of the Los Alamos thermoluminescent dosimeter (TLD) to high energy neutrons warranted issuing a NTA dosimeter in addition to the TLD badge to employees entering these areas. The dosimeter consists of a plastic holder surrounding NTA film that has been desiccated and sealed in a dry nitrogen environment. A study of the fading of latent images in NTA film demonstrated the success of this packaging method to control the phenomenon. The Los Alamos NTA dosimeter is characterized and the fading study discussed. 10 refs., 4 figs., 2 tabs.

22754 (LA-UR–90-419) **Laser-produced plasmas in medicine.** Gitomer, S.J.; Jones, R.D. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900178–2: Biomedical optics '90, Los Angeles, CA (USA), 14-19 Jan 1990). Order Number DE90007623. Available from NTIS, PC A03/MF A01 - OSTI.

The laser has found numerous applications in medicine, beginning with uses in ophthalmology in the 1960's. Today, lasers are used in tissue cutting, blood coagulation, photo-dynamic cancer therapy, arterial plaque removal, dental drilling, etc. In this paper, we examine those areas of laser medicine in which plasmas (ionized gases) are produced. In fact, the presence of a plasma is essential for the application at hand to succeed. We consider examples of the plasmas produced in ophthalmology (e.g., lens membrane destruction following cataract surgery), in urology and gastroenterology (e.g., kidney and gall stone ablation and fragmentation) and in cardiology and vascular surgery (e.g., laser ablation

and removal of fibro-fatty and calcified arterial plaque). Experimental data are presented along with some results from computer simulations of the phenomena. Comments on future directions in these areas are included. 63 refs.

22755 (LBL–27460) **Life sciences: Lawrence Berkeley Laboratory, 1988.** Lawrence Berkeley Lab., CA (USA). Jul 1989. 76p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008061. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Life Sciences Research at LBL has both a long history and a new visibility. The physics technologies pioneered in the days of Ernest O. Lawrence found almost immediate application in the medical research conducted by Ernest's brother, John Lawrence. And the tradition of nuclear medicine continues today, largely uninterrupted for more than 50 years. Until recently, though, life sciences research has been a secondary force at the Lawrence Berkeley Laboratory (LBL). Today, a true multi-program laboratory has emerged, in which the life sciences participate as a full partner. The LBL Human Genome Center is a contribution to the growing international effort to map the human genome. Its achievements represent LBL divisions, including Engineering, Materials and Chemical Sciences, and Information and Computing Sciences, along with Cell and Molecular Biology and Chemical Biodynamics. The Advanced Light Source Life Sciences Center will comprise not only beamlines and experimental end stations, but also supporting laboratories and office space for scientists from across the US. This effort reflects a confluence of scientific disciplines — this time represented by individuals from the life sciences divisions and by engineers and physicists associated with the Advanced Light Source project. And finally, this report itself, the first summarizing the efforts of all four life sciences divisions, suggests a new spirit of cooperation. 30 figs.

22756 (LBL–28042) **Biological soft x-ray contact microscopy: Imaging living CHO-SC1 cells and other biological materials.** Guttmann, G.D. Lawrence Berkeley Lab., CA (USA). Aug 1989. 223p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Contract F49620-87-K-0001. Order Number DE90007560. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This dissertation is a description of soft x-ray contact microscopy and the successful efforts to expand this technique to image at high resolution, living mammalian cells. Soft x-ray contact microscopy (SXCM) is a form of x-ray lithography, however, the biological cell is imaged instead of an electron-cut microcircuit mask. The contrast mechanism is based upon the x-ray absorption lengths of carbon and nitrogen. The soft x-rays were generated by a conventional laboratory source or a laser-induced plasma x-ray source. The conventional laboratory soft x-ray source, was a converted electron evaporator. The target materials were vanadium, and carbon. The laser-induced plasma x-ray source was the Lawrence Livermore National Laboratory (LLNL) JANUS laser facility. The target material was tantalum. A radiachromic nylon film was used to calibrate the exposure dose. The imaging detector was an x-ray sensitive resist or a copolymer. A wet cell chamber (WCC) was designed to keep a biological sample alive at atmospheric pressure yet permit imaging by soft x-rays. The limits of resolution required an understanding of the interaction of soft x-rays with matter, Fresnel diffraction, penumbral blurring and secondary electron travel within a resist. The imaging of the biological samples included sample preparation, resist development and electron microscope readout of the resist. The biological samples were fixed erythrocytes and zymogen granules, and critical point dried 9L glialsarcoma cells. The major result of this work was the first pictures of living mammalian cells, CHO-SC1, by SXCM. The LLNL JANUS laser facility was the x-ray source for the living cell x-ray micrographs. 155 refs., 69 figs.

22757 (MBL–1989-3) **Detection of DNA damage in cells exposed to ionizing radiation by use of antisingle-stranded-DNA monoclonal antibody.** Schans, G.P. van der (Rijksverdedigingsorganisatie TNO, Rijswijk (Netherlands). Medisch Biologisch Lab. TNO); Loon, A.A.W.M. van; Groenendijk, R.H.; Baan, R.A. TNO-Rijksuniversiteit Leiden Collaboration. Rijksverdedigingsorganisatie TNO, Rijswijk (Netherlands). Medisch Biologisch Lab. TNO. Mar 1989. 26p. Contract A83/K/70(HDO Assignment No.). Order Number DE90619498. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Inlcudes summary, motivation and explanatory note in Dutch.

An immunochemical method has been developed for quantitative detection of DNA damage in mammalian cells. The method is based on the binding of a monoclonal antibody to single-stranded DNA. The clone producing this antibody, D1B, was obtained as a by-product from fusion of mouse myeloma cells with spleen cells isolated from a mouse immunized with chemically modified DNA. The technique is based upon the determination of the percentage single-strandedness resulting from the partial unwinding of cellular DNA under alkaline conditions, a time-dependent process. Single-strand and double-strand DNA breaks, or lesions converted into such breaks in alkaline medium, form initiation points for the unwinding. The extent of unwinding under controlled conditions is a measure, therefore, of the amount of such sites. The method is rapid, does not require radioactive labelling of DNA or physical separation of single- from double-stranded molecules, is sufficiently sensitive to detect damage induced by 1 Gu of ionizing radiation and needs only small amounts of cells. The usefulness of the technique was demonstrated in a study on the induction of damage and its repair in unlabelled cultured Chinese hamster cells and in DNA-containing cells of human blood, both after exposure to ^{60}Co-γ-rays, and in white blood cells and bone marrow cells of X-irradiated mice. A dose-related degree of unwinding was observed and repair could be observed up to 60 min after irradiation. (author). 19 refs.; 3 figs.; 1 tab.

22758 (MBL–1989-5-A83/K/70) **Biological dosimetry of radiation damage.** Schans, G.P. van der; Lon, A.A.W.M. van; Baan, R.A. Dutch Ministery of Defense-TNO/MBL Collaboration. Rijksverdedigingsorganisatie TNO, Rijswijk (Netherlands). Medisch Biologisch Lab. TNO. 17 Nov 1989. 46p. Available from Library KNAW; P.O.Box 41950, 1009 DD Amsterdam, Netherlands. Available from Library KNAW; P.O.Box 41950, 1009 DD Amsterdam, Netherlands.

Includes summary in Dutch.

Immunochemical methods have been developed for the quantitative detection of radiation-damage in DNA in mammalian cells. One of these methods is based on the binding of monoclonal antibodies to single-stranded DNA. This single-stranded DNA is generated by unwinding due to radiation damage in DNA and the amplification of the unwinding by a subsequent alkali-treatment. The lower detection limit is about 0.5 Gy, directly after irradiation. After further development of the method the amount of damage can be assessed within 2 h after sampling. Furthermore, the method is expected to be applicable at the single-cell level which will open the possibility to distinguish between partial and total body irradiation. The development of this method has been described in MBL-report 1989-3. In this report the exploratory investigations performed in the initial stages of this project are described. 14 refs.; 13 figs.; 3 tabs.

22759 (NVS–10) **Emergency reception of accidents and incidents in working with ionizing radiation.** Abrahamse, J.C.; Gispen, J.G.W. Nederlandse Vereniging voor Stralingshygiene, Eindhoven (Netherlands). 1989. 24p. (In Dutch). Order Number DE90706053. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This manual is intended to be a general manual for the responsible expert regarding radiation hygienics in order to assist him in establishing an organization for combat of accidents and incidents. First attention is paid considerations underlying emergency measures and aid, subsequently the demands and desirabilities in the practical organization are discussed. 3 figs.

22760 (ORNL–6590) **Activation of cobalt by neutrons from the Hiroshima bomb.** Kerr, G.D. (Oak Ridge National Lab., TN (USA)); Dyer, F.F.; Emery, J.F.; Pace, J.V. III; Brodzinski, R.L.; Marcum, J. Oak Ridge National Lab., TN (USA). Feb 1990. 83p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90008018. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

A study has been completed of cobalt activation in samples from two new locations in Hiroshima. The samples consisted of a piece of steel from a bridge located at a distance of about 1300 m from

the hypocenter and pieces of both steel and concrete from a building located at approximately 700 m. The concrete was analyzed to obtain information needed to calculate the cobalt activation in the two steel samples. Close agreement was found between calculated and measured values for cobalt activation of the steel sample from the building at 700 m. It was found, however, that the measured values for the bridge sample at 1300 m were approximately twice the calculated values. Thus, the new results confirm the existence of a systematic error in the transport calculations for neutrons from the Hiroshima bomb. 52 refs., 32 figs., 16 tabs.

22761 (PB–90-130626/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on radiation before the Senate Committee on Commerce, Science, and Transportation, by Elliot Harris, June 28, 1977.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 28 Jun 1977. 12p. Available from NTIS, PC A03/MF A01.

The statement concerned National Institute for Occupational Safety and Health (NIOSH) research programs relating to occupational exposure to radiation. Much epidemiological data points to exposure to radon daughters as hazards to uranium miners and milling operators. Problems also arise from the operation of radiation-generating equipment. Nonionizing radiation hazards included visible, ultraviolet, radiofrequency and microwave radiation, infrared and ultrasonic radiation. Ultraviolet radiation can cause sunburn, eye damage, depigmentation, precancerous tumors, basal and squamous cell cancers, and malignant melanomas. Infrared radiation has been implicated in the development of cataracts. Laser radiation was linked with burns and fire hazards. The only hazard associated with visible radiation thus far has been eyestrain due to the lack of sufficient light while performing a given task. Optical radiation exposures occurred among workers using cathode ray tubes, such as computer screens, in their jobs. Workers were exposed to many sources of microwave and radiofrequency radiation from radio and radar transmitters, industrial drying equipment, heat sealing and curing equipment, and certain medical research devices. Training and support services were mentioned.

22762 (PNL–6100-Pt.4, pp. 22-23) **Bethe-born theory of ionization by high-velocity ions and electrons.** Miller, J.H.; Wilson, W.E. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

A comprehensive and accurate data base of collision cross sections is required for a detailed description of the absorption of ionizing radiation in biologically significant materials. Two contributions on the application of Beth's asymptotic expansion theory to the analysis of differential ionization cross sections were made this year. The first of these involves the energy spectrum of secondary electrons that are ejected from water by fast bare ions and electrons. Our second contribution in this area concerns the spectrum of secondary electrons produced when structured ions collide with atomic and molecular targets. As was the case for bare ions, models of ionization by structured ions rely on the separation of target and projectile properties afforded by the first Born approximation to the quantum collision theory. The Compton profile of the projectile gives the contribution to the momentum of electrons moving with the projectile from their motion about the nucleus of the projectile. Given the total momentum of these electrons, stripping can be viewed as electron scattering by the target. The dominant contribution to the differential stripping cross section is provided by elastic scattering, but inelastic scattering may also occur; this phenomenon contributes to the cross section for simultaneous projectile stripping and target ionization. The dominant role of bound electrons on the projectile in target ionization is screening of the projectile's nuclear charge.

22763 (PNL–6100-Pt.4, pp. 33-35) **A comparison of microscopic dose with average dose near high-energy iron ions.** Metting, N.F.; Braby, L.A. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The primary goal underlying the Radiation Dosimetry task is to understand the connections between the physical events produced by the interaction of ionizing radiation with matter and their biological consequences. Biophysical studies indicate that the mechanisms responsible for radiation effects in biological systems involve injury to cell substructures much smaller than a cell nucleus. To understand the molecular mechanisms responsible, it is important to know the probable amount of dose deposited in the microscopic volumes of interest for a particular biological and point. This probability depends on the type of radiation, and is expected to correlate with the biological effects observed. At the Bevalac accelerator at Lawrence Berkeley Laboratory, a small proportional counter (PC) mounted in the large vacuum chamber was used to measure single-event energy deposition distributions as a function of the distance radially outward from the primary ion path, for a 1.3-μm-diameter site. In the case of heavy ion passage through tissue, the local pattern of energy deposition in critical volumes is strongly influenced by the frequency and range of secondary electrons. One homogeneous track structure model predicts a quantity called an energy density or local dose, which is a function of the radial distance. If the velocity of the ion is varied each new delta-ray energy distribution would be predictable, but the deposition of energy in matter is a complex function of that distribution. One cannot extrapolate precisely to determine spectra for other velocities using only the measurements taken at one velocity. The best that can be done short of a Monte Carlo simulation (or direct measurement) is estimation track structure model.

22764 (PNL–6100-Pt.4, pp. 46-47) **Kinetics of C3H 10T1/2 mouse cells.** Metting, N.F.; Mortenson, E.; Braby, L.A.; Nelson, J.M. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The 10T1/2 cell line has been brought to PNL because of its usefulness as an in vitro biological system for transformation assay, and because a fast repair process in response to irradiation has been observed in these cells. Before using the cells in radiobiological studies, it was important to observe the growth kinetics of our cultures and verify their similarity to those reported by other laboratories in which they are used, so that our subsequent measurements could be compared with and added to the body of scientific work already compiled. To become familiar with the cell morphology and cloning characteristics, we conducted an experiment in which a number of flasks were seeded with about 350 cells each. Each day, starting with the second day after plating, a flask was stained and the number of clones plus the number of cells in each clone were counted. There are several types of cell morphologies within the population. Flow cytometry (FCM) studies were used to assess cell cycle characteristics, Again, a number of flasks were seeded, but this time with a large number of exponentially growing cells. Measurements indicated that the cultures were probably more or less synchronized at their initiation by plating efficiency effects, that they maintained a loose synchrony by phases through about the eighth day and that before at least the eleventh day they began to pile up in G1 phase.

22765 (VR–89-05) **Reports from the RIVM 1988.** Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. 344p. (In Dutch). Order Number DE90619461. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

In this report the progress and developments of the departments within the headsectors; Microbiology and Immunology, Pharmacology and Toxicology, Chemistry and Physics, of the Dutch National Institute for Environment Hygiene and Public Health (RIVM) over the year 1988, and a collection of separate research papers are presented. Three of these are in INIS scope, one dealing with calibration of plan-parallel ionization chambers used in radiotherapy, one treating some aspects of the action mechanism of gamma- and UV-radiation at cellular level, and an account of the Dutch Coordination-Committee for Measurements of Radioactivity and Xenobiotic (CCRX). (H.W.). refs.; figs.; tabs.

22766 (VR–89-05, pp. 320-323) **Fundamental aspects of the mechanisms of gamma-radiation and ultraviolet-radiation.**

Leenhouts, H.P.; Chadwick, K.H.; Wijngaard, E.; Sijsma, M.J. Ministerie WVC-RIVM collaboration. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). 1988. (In Dutch). In *Reports from the RIVM 1988.* Order Number DE90619461. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Some aspects of the mechanism of action at a cellular level of gamma- and UV-radiation and their possible consequences upon radiation hazards, are discussed. (author). 5 refs.; 5 figs.; 1 tab.

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 21329, 22129, 22517, 22520, 22547, 22577, 22598, 22615

22767 (DOE/EA–0407) **Liquefied Gaseous Fuels Spill Test Facility program: Eleven additional chemicals: Environmental Assessment.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Dec 1989. 140p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008109. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

An Environmental Assessment (EA) has been prepared to assess the environmental consequences of spill testing eleven hazardous materials at the Liquefied Gaseous Fuels Spill Test Facility (LGF-STF) at Frenchman Flat, Nevada Test Site (NTS). These chemicals are: chlorosulfonic acid, fluorosulfonic acid, hydrogen chloride, methyl trichlorosilane, nitrogen tetroxide, oleum, silicon tetrachloride, sulfur-trioxide, titanium tetrachloride, trichlorosilane, and unsymmetrical dimethyl hydrazine. DOE has determined that the proposed spill testing of these eleven hazardous materials at LGF-STF at Frenchman Flat is not a major federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA). Therefore, an environmental impact statement (EIS) will not be prepared.

22768 (DOE/ER–0439) **Summary results of an assessment of research projects in the Chemical Toxicology Research Program.** USDOE Office of Energy Research, Washington, DC (USA). Office of Program Analysis. Feb 1990. 6p. Sponsored by U.S. DOE Energy Research. Order Number DE90008118. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Chemical Toxicology Research Program of the Department of Energy (DOE) sponsors fundamental and applied research to understand the interactions with living systems of chemicals associated with energy activities. A companion effort investigates the effects of radiation on biological systems. The Office of Program Analysis (OPA) undertook an assessment of the quality of projects in the DOE Chemical Toxicology Research Program. The purpose of this assessment was to obtain sufficient information for Office of Health and Environmental Research managers to determine overall quality of research in the Chemical Toxicology Research Program, overall quality of research within subprograms of the Chemical Toxicology Research Program, quality of individual research projects within the Chemical Toxicology Research Program, and priority research targets and opportunities for future sponsorship by the Chemical Toxicology Research Program. 1 fig.

22769 (Juel-Spez–503) **Search for indicatory criteria to predict effects of chemical induced stress on ecosystemal level. Vol. 12. Final reports of sponsored projects. Pt. 2.** Scheele, B.; Verfondern, M. (comps.). Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung Biologie, Oekologie, Energie (PBE). Jun 1989. 560p. (In German). Order Number DE90759497. Available from NTIS (US Sales Only), PC A24/MF A01; OSIT; INIS.

This is the second and last part of reports on results of a research program titled 'Search for Indicatory Criteria to Predict Effects of Chemical Induced Stress on Ecosystemal Level'. These studies have been supported by the German Ministry of Research and Technology since 1980/81. They deal with structural and in some cases as well with functional reactions of terrestrial ecosystems on chemical stress. On the basis of this knowledge, indicatory criteria for the ecosystem itself as well as chemical damage are developed and their efficiency is discussed. The report contains the following 3 final reports: Studies of the effects of chemicals on forest ecosystems and their regenerative ability by means of parasitoids as bioindicators; Development of indicators for the effects of chemical pollutants on meadowland ecosystems; Residue analyses of environmental pollutants in compartments of terrestrial ecosystems. As a supplement to the 2nd report a short report is added with the title: Residue analyses of environmental pollutants in compartments of terrestrial ecosystems. Separate abstracts were prepared for 3 of the reports of this volume. (orig./MG).

22770 (Juel-Spez–503 A1-A166) **Studies of the effects of chemicals on forest ecosystems and their regenerative ability by means of parasitoids as bioindicators.** Albert, A.M. (Forstliche Versuchs- und Forschungsanstalt Baden-Wuerttemberg, Freiburg im Breisgau (Germany, F.R.). Abt. Waldschutz). Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung Biologie, Oekologie, Energie (PBE). Jun 1989. (In German). In *Search for indicatory criteria to predict effects of chemical induced stress on ecosystemal level. Vol. 12. Final reports of sponsored projects. Pt. 2.* Order Number DE90759497. Available from NTIS (US Sales Only), PC A24/MF A01; OSTI; INIS.

The effect of a chemical application on the epigeic fauna, especially parasitic Hymenoptera, of an oak-hornbeam-forest was studied by means of ground photoelectors. In a large area project two out of three study plots of 1 ha size each received a single treatment with cypermethrin resp. propoxur. In other experiments with small ground photoelectors only small areas were treated with several chemicals. The following parameters, on the basis of animal groups (orders, families) or species, are suitable bioindicators for chemical stress in ecosystems: 1. alternations in numbers of caught animals, 2. alterations in dominance identity between experimental and control plot and between different years on the same plot, 3. alterations in height and direction of fluctuations, especially variance of the fluctuation coefficients. To a lesser degree, also changes in trophic structure can be used. (orig./MG).

22771 (Juel-Spez–503 B-B195) **Definition of indicators for the effects of chemical pollutants on meadowland ecosystems.** Runge, M.; Schaefer, M.; Werner, W.; Conrady, D.; Neemann, G.; Stickan, W. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung Biologie, Oekologie, Energie (PBE). Jun 1989. (In German). Contract BMFT 0373259. In *Search for indicatory criteria to predict effects of chemical induced stress on ecosystemal level. Vol. 12. Final reports of sponsored projects. Pt. 2.* Order Number DE90759497. Available from NTIS (US Sales Only), PC A24/MF A01.

A pasture of white clover (Lolio-Cynosuretum) and one of golden oat grass (Poo-Trisetetum flavescentis Festuca-rubra facies) were analyzed for their sensitivity and the regeneration capacities of their different species after exposure to environmental pollutants (pentachlorophenol and 2,4-dichlorophenoxyacetic acid). The investigations were to describe the reaction of the phytocoenosis and zoocoenosis on the basis of changes within species or groups of species (e.g. the totality of plant stack as an indicator), to investigate ecosystem structures or processes for their applicability as indicators (e.g. primary production, litter decomposition rate), to compare the effects of a single, high-level exposure with those of repeated low-level exposure, and to test the specific sensitivity of individual animal and plant species. The results are presented and discussed. (orig./MG).

22772 (PB–90-130527/XAB) **Report on cancer risks associated with the ingestion of asbestos.** Lemen, R.; Meinhardt, T.; Becking, G.; Cantor, K.; Cherner, J. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Jan 1986. 51p. Available from NTIS, PC A04/MF A01.

Cancer risks associated with ingestion of asbestos are discussed. Asbestos contamination of drinking water is considered. At least 66.5% of the United States water systems are capable of eroding asbestos cement pipes. The ability of water to leach asbestos from asbestos cement pipes can be modified by coatings applied to the inside pipe surface. Asbestos contamination in foods or pharmaceuticals is discussed. Asbestos fibers at concentrations of 1.1 to 172.7 million fibers per liter have been found in beverages. To date, studies supported by the Food and Drug Administration (FDA) have provided no evidence that ingesting asbestos results in

an increased cancer risk. The FDA has determined that no prohibition on using asbestos filters in processing food, beverages, and non-parenteral drugs is needed. Toxicological studies on asbestos ingestion and carcinogenicity are reviewed. Epidemiological evaluations of the association between drinking-water supplies containing asbestos and cancer mortality are discussed. It is concluded that the available information is insufficient for assessing the risk of cancer associated with ingesting asbestos.

22773 (PB–90-131582/XAB) **Registry of Toxic Effects of Chemical Substances (RTECS), 1988 edition. User's guide to the RETECS computer tape.** Sweet, D.V. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Oct 1989. 94p. Available from NTIS, PC A05/MF A01.

Supersedes PB–87-222246. For system on magnetic tape, see PB–89-900300. For system on diskette, see PB–89-121487.

The User's Guide describes the tape characteristics and the file layout of the Registry of Toxic Effects of Chemical Substances (RTECS) as it appears on the RTECS computer tape. It also includes the Introduction to the RTECS and the Detailed File Description of the RTECS, as well as tables, figures, and appendices.

22774 (PB–90-855982/XAB) **Toxicity of mercury and mercury compounds. May 1978-August 1989 (Citations from Pollution Abstracts). Report for May 1978-August 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 94p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxic effects of mercury and mercury compounds on biological systems. Mercury halides, organic mercury compounds, mercury metal, mercury vapors, and other compounds are discussed. Metabolism, toxicology, occupational exposure, symptoms of exposure, mechanisms of interaction with biological systems, demographics of mercury accumulation and poisoning, and case reports are considered. Heavy-metal pollution and bioaccumulation are referenced in related published bibliographies. (Contains 204 citations fully indexed and including a title list.)

22775 (PB–90-856071/XAB) **Benzene toxicity. March 1978-July 1989 (Citations from the Life Sciences Collection data base). Report for March 1978-July 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 140p. Available from NTISPC N01/MF N01.

Supersedes PB–88-866371.

This bibliography contains citations concerning toxicity of benzene following short- and long-term exposure. The metabolism, carcinogenicity, and teratogenic potential of benzene are considered. Methodology to quantitate its presence in the atmosphere, body tissues, and body fluids are discussed. Occupational hazards of benzene are included. (This updated bibliography contains 327 citations, 33 of which are new entries to the previous edition.)

22776 (PNL–6100-Pt.4, pp. 1-4) **Determination of adducts of benzo[a]pyrene to deoxyribonucleic acid using gas chromatography/mass spectrometry techniques.** Chess, E.K.; Thomas, B.L.; Springer, D.L.; Mann, D.B.; Hendren, D.J.; Bean, R.M. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Adducts to deoxyribonucleic acid (DNA), formed from metabolites of polynuclear aromatic compounds, are relatively persistent and correlate with bioresponse (carcinogenicity). Therefore, qualitative and quantitative analyses of adducts in the DNA of individuals may provide valuable information on recent exposure to carcinogenic hydrocarbons. The basic thrust of the analytical development at PNL is to isolate the DNA, liberate the adducted hydrocarbon residue from the DNA with acid hydrolysis, and prepare derivatives of the hydrolyzed species that will enhance its detection, quantitation, and characterization using gas chromatography/mass spectrometry (GC/MS). We have initiated the development of the necessary techniques using benzo[a]pyrene (BaP) and its metabolites. Samples of DNA adducts of radiolabeled BaP have been prepared for study by reacting DNA isolated from calf thymus with benzo[a]pyrene-7,8-diol-9,10-epoxide (the ultimate carcinogenic form of BaP). The identity of the synthesized adduct was confirmed by mass spectrometry. Initial experiments determined that the derivatized metabolites could be detected during single-ion monitoring (SIM) GC/MS analyses using a mass selective detector. These levels of sensitivity are sufficient to detect the amounts of DNA-bound metabolites isolated from laboratory animals exposed to relatively high levels of carcinogens, and may be sufficient to detect the hydrolyzed metabolites at levels that can be isolated from environmentally exposed systems. Results from the initial methodology development stages of this assay indicate to use that GC/MS analysis using SIM can provide the specificity and sensitivity required for the quantitative determination of derivatized PAH metabolites isolated from DNA adducts that have been formed as a result of environmental exposure to PAH.

22777 (PNL–6100-Pt.4, pp. 4-5) **Disappearance of benzo[a]pyrene and other polycyclic aromatic hydrocarbons from mouse skin in vivo.** Wright, C.W.; Dankovic, D.A. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Previous experimental data showed that increased skin tumor initiation activity of complex coal-derived mixtures was correlated with products of higher boiling-point ranges and that the neutral PAH fraction of these complex mixtures was the most active fraction, using skin tumor initiation as a biological endpoint. When added to benzo[a]pyrene (BaP), however, the high-boiling coal-derived mixtures have suppressed the skin tumorigenicity of the carcinogenic parent compound, indicating that the tumorigenic coal-derived mixtures are not additive with BaP carcinogenicity, but appear to be inhibitory. In the present work, the effects of the PAH fraction isolated from a high-boiling coal-derived complex mixture of the rate of disappearance of BaP from mouse skin in vivo were examined. The rate of disappearance from mouse skin was used as an indirect measure of the rate of BaP uptake and metabolic activation by the mixed function oxidase (MFO) system of mouse skin. In addition, the individual rates of disappearance from mouse skin of 12 PAH compounds in the PAH fraction were determined from quantitative high-resolution gas chromatographic analysis of hexane extracts. The components quantified in the extracts were identified by retention time and mass spectral information. Coal-derived complex mixtures have been noted to yield decreased tumorigenic potency when increased concentrations of highly alkylated species were present. The skin half-life of the 25-μg dose of BaP applied alone was significantly shorter than the skin half-life of a nearly comparable dose applied with the complex PAH fraction isolated from the coal liquid. The apparent inhibition of skin metabolism may be related to the observed inhibition of skin tumor initiating activity of BaP and the observed inhibition of BaP binding in skin when in the presence of complex coal-derived liquids.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 22761

22778 (AD-A–214805/4/XAB) **Effect of exposure to microwaves on the neuroendocrine status of the rat. Final report, 1 January 1979-30 June 1980.** Stith, R.D. Oklahoma Univ., Oklahoma City, OK (USA). Health Sciences Center. 31 Aug 1980. 17p. Available from NTIS, PC A03/MF A01.

Male Sprague-Dawley rats were restrained individually in a polyethylene box and placed in the far field of 1.2 CH_3, parallel to the electric field. Rats were irradiated for 30 minutes with either no power, continuous wave, or pulsed wave radiation of 5 or 15 mW/cm^2, average density. Groups of rats were also employed which had been subjected to stress or external heating in place of microwave radiation. At the end of the exposure period, rats were sacrificed by guillotine and hypothalamus, brain stem, and blood samples obtained. Tissues were quick-frozen and stored at -20 C until analyses. Brain tissues were assayed for tyrosine hydroxylase activity (TH) and norepinephrine (NE) and dopamine (DA) concentrations. Results reveal that hypothalamic TH and DA, but not NE were depressed after exposure to microwaves. Brainstem TH and DA were also depressed, but not to as great a degree as in hypothalamus, and mainly to 15 mW/cm2 (CW or PW) rather than 5

mW/cm2. Brainstem NE was unaffected. These data reveal that effects of acute microwave exposure on the brain can be detected. The changes observed were apparently not due to elevated adrenal corticoid levels from the to heating of the animals. Further investigation is suggested to clarify this phenomenon and its relationship to the physiology of the organism.

22779 (AD-A–214878/1/XAB) **Cumulative airport noise-exposure metrics: An assessment of evidence for time-of-day weightings. Revision.** Fields, J.M. Southwest Research Inst., San Antonio, TX (USA). Nov 1989. 180p. Available from NTIS, PC A09/MF A01.

Revision of report dated Nov 86, AD-A174-848.

The differential impact of noise on residents at different times of day is examined in analyses of the original machine-readable data from ten community surveys and in detailed reviews of the published results from 20 additional surveys. Analyses are conducted using alternative community response measures and analysis techniques. The primary objective of these analyses is to determine the relative impact of noise during the daytime and nighttime by estimating the value of a time-day weighting in the adjusted energy model. Some support is found for nighttime and evening weightings, however, the estimates of these time-of-day weightings are found to be highly accurate. Examinations of the factors affecting this accuracy lead to the conclusion that studies of community response to noise will not provide a usefully accurate estimation of the time-of-day weighting parameter in the adjusted energy model. This report provides data on proportions of the United States population engaged in noise-sensitive activities at different times of day. The report reproduces all social survey results in which averages of nighttime response are plotted by nighttime noise levels. Analyses are conducted of the relationship between daytime and nighttime noise environments around United States airports.

57 HEALTH AND SAFETY

22780 (AECB/ACNS–INF00299(E)) **Alternative electical energy systems: A comparison of the risks of occupational and public fatalities: Executive summary.** Atomic Energy Control Board, Ottawa, ON (Canada). Advisory Committee on Nuclear Safety. Mar 1989. 97p. (MICROLOG–90-01129). Available from PC Canada. Atomic Energy Control Board, 270 Albert St., P.O. Box 1046, Ottawa, ON, CAN K1P 5S9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The occupational and public health risks of different electrical energy production systems have been the subject of many studies in recent years. This report concentrates on the comparative risks of large coal, nuclear and hydraulic plants. Brief summaries of risk estimates for oil- and gas-fired electric power plants are appended. The report deals mainly with the risks of fatalities, whether by accident or disease, arising from normal operation but includes a discussion of the risks of catastrophic accidents. A literature search was conducted for objective critical evaluations or recent risk studies of electrical energy systems. A risk assessment method designed by Niehaus and Paskievici was used. The report first describes and summarizes international data, then describes risk estimates for the Canadian situation. It is concluded that the occupational risks of the coal fuel cycle are about 2-4 times higher than those from the nuclear or hydraulic systems, and that the public risks from the coal-fired system are also somewhat greater than those from the nuclear or hydraulic systems.

22781 (HAZ–CE02854) **Haztech Canada '88: Dangerous goods and hazardous waste management conference proceedings.** Haztech Canada, Edmonton, AB (Canada). 1988. 382p. (CONF-8805352–: Haztech Canada '88: dangerous goods and hazardous waste management conference, Mississauga (Canada), 10-12 May 1988; CE–02854). Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

This conferences was called to provide a forum for dicussion of the management of hazardous materials, both chemical and biological. The topics covered are: pollution abatement at the source and during the transport, protection and decontamination of the environment (especially soils and aquifers), decommissioning of industrial installations, chemical monitoring of wastes and contaminated media, fire and accident prevention, regulations and economics. Separate abstracts have been prepared for 4 papers from this conference.

22782 (OH/RD–88-56-K) **Comments on the analysis of occupational exposure to PCBs and various cancers by the Industrial disease standard panel.** Camacho, F. Ontario Hydro Research Div., Toronto, ON (Canada). 21 Mar 1988. 5p. (MICROLOG–89-02586). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

The analysis presented in the Report to the Worker's Compensation Board on Occupational Exposure to polychlorinated biphenyls (PCBs) during the manufacture of electrical capacitors and occurrence of various. cancers is reviewed. It is concluded that important objections can be raised to some of the arguments in the Report. These objections may be summarized as follows: the available evidence does not support the finding of the Report that compelling epidemiological evidence of excess cancers appears for the liver, biliary tract and gall bladder cancers. The reviewed evidence does not support the existence of a significant link between these cancer incidences and the exposure to PCBs. While such a connection is possible, more information is needed to establish the significance of the link. 8 refs.

22783 (ORNL/TM–11421) **Environmental protection for hazardous materials incidents.** Barkenbus, B.D.; Carter, R.J.; Dobson, J.E.; Easterly, C.E.; Ogle, P.S.; VanCleave, A.K. Oak Ridge National Lab., TN (USA). Feb 1990. 602p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90008070. Available from NTIS, PC A25/MF A01 - OSTI.

This document was prepared to provide the US Air Force fire protection community with an integrated program for handling hazardous materials (HAZMAT)s and hazardous material incidents. The goal of the project was to define and identify a computer system for the base fire departments that would facilitate hazard assessment and response during HAZMAT emergencies, provide HAZMAT incident management guidelines, and provide a training tool to simulate emergency response during normal times. Site visits to Air Force bases were made to observe existing HAZMAT related organizations, their methods and procedures used in HAZMAT management, and to collect personnel input for the development of the computerized Hazardous Materials Incident Management System (HMIMS). The study concentrated on defining strategic areas of concern to emergency response personnel. Particular emphasis was given to such areas as responsibilities and roles for response agencies; personnel requirements to handle HAZMAT incidents; procedures to follow during HAZMAT incidents and decontamination; personnel evacuation; postincident evaluation and feedback; emergency response personnel participation in installation restoration program; personal protective clothing; mutual air requirements; and training. Future recommendations were made for purchase, use, storage, disposal, and management of HAZMATs during their life cycle on bases and during incidents. This detailed technical report and the HMIMS are expected to meet the integrated HAZMAT program needs primarily of Air Force fire departments and secondarily in other response agencies. 21 figs., 6 tabs.

58 GEOSCIENCES

Refer also to citation(s) 21162, 21201, 21384, 21495, 21502, 21503, 21504, 21531, 21537, 21538, 21877, 21908, 22216, 22543

22784 (BNL–43503) **Shelf Edge Exchange Processes-2: SEEP2-01, R/V ENDEAVOR cruise 172: Hydrographic data report.** Behrens, W.J.; Wilson, C.; Flagg, C.N.; Wallace, D.W.R.;

Wilke, R.J.; Wyman, K.D. Brookhaven National Lab., Upton, NY (USA). Nov 1989. 235p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008288. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The R/V ENDEAVOR cruise 172, SEEP2-01, took place from 5–20 February, 1988 and deployed ten moorings along two cross-shelf lines (referred to as the North and South lines) across the outer continental shelf. Acoustic Doppler current profilers (ADCP) were deployed in conjunction with four of the moorings. During this cruise 47 CTD casts were made measuring pressure, temperature, conductivity, dissolved oxygen, fluorescence and light transmission. Discrete samples were taken in rosette-mounted Niskin bottles and analyzed for concentration of nutrients, chlorophyll a, dissolved oxygen, and particulate organic carbon and nitrogen.

22785 (BNL–43504) **Shelf Edge Exchange Processes-2: Seep2-02, R/V CAPE HATTERAS cruise CH01-88: Hydrographic data report.** Wilson, C.; Behrens, W.J.; Flagg, C.N.; Wallace, D.W.R.; Wilke, R.J.; Wyman, K.D. Brookhaven National Lab., Upton, NY (USA). Nov 1989. 340p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008505. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

The R/V CAPE HATTERAS cruise CH01-88, SEEP2-02, took place from 3–20 March, 1988 and focused primarily on biological processes in the SEEP2 area. A short term sediment trap mooring was deployed near mooring 1 and recovered during the cruise. The mooring consisted of two 0.07 sq. meter and one 0.7 sq. meter sediment traps. Two time series, approximately 48 hours each, were conducted in the area of the sediment trap mooring. The time series were designed to study primary and secondary productivity and involved sampling nutrients, dissolved oxygen, chlorophyll, zooplankton abundance and distribution, and zooplankton fecal pellet distribution. Experiments to estimate grazing rates and fecal pellet production of the dominant copepods were also done. Sediment trap and zooplankton data are not reported here. During this cruise 99 CTD casts were made measuring pressure, temperature, conductivity, dissolved oxygen, fluorescence and light transmission. Discrete samples were taken in rosette-mounted Niskin bottles and analyzed for concentration of nutrients, chlorophyll a, dissolved oxygen, and particulate organic carbon and nitrogen.

22786 (BNL–43641) **Shelf Edge Exchange Processes-2: SEEP2-03, R/V ENDEAVOR cruise 178: Hydrographic data report.** Behrens, W.J.; Wilson, C.; Flagg, C.N.; Wallace, D.W.R.; Wilke, R.J.; Wyman, K.D. Brookhaven National Lab., Upton, NY (USA). Nov 1989. 212p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008290. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The R/V ENDEAVOR cruise 178, SEEP2-03, took place from 8–13 June, 1988 and recovered ten moorings along two cross-shelf lines (referred to as the North and South lines) across the outer continental shelf. During this cruise 35 CTD casts were made measuring pressure, temperature, conductivity, dissolved oxygen, fluorescence and light transmission. Discrete samples were taken in rosette-mounted Niskin bottles and analyzed for concentration of nutrients, chlorophyll a, dissolved oxygen, and particulate organic carbon and nitrogen.

22787 **The Atlantic continental margin: US: Decade of North American Geology Project.** The Geology of North America, Volume I-2. Sheridan, R.E. (Rutgers–the State Univ., New Brunswick, NJ (USA). Dept. of Geological Sciences); Grow, J.A. (eds.). 610p. The Geological Society of America, Inc., Boulder, CO (USA) (1988). Sponsored by U.S. DOE Energy Research. DOE Contract FG01-84ER13182.

The Geology of North America series has been prepared to mark the Centennial of The Geological Society of America. It represents the cooperative efforts of more than 1000 individuals from academia, state and federal agencies of many countries, and industry to prepare syntheses that are as current and authoritative as possible about the geology of the North American continent and adjacent oceanic regions. This series is part of the Decade of North American Geology (DNAG) Project which also includes eight wall maps at a scale of 1:5,000,000 that summarize the geology, tectonics, magnetic and gravity anomaly patterns, regional stress fields, thermal aspects, seismicity and neotectonics of North America and its surroundings. Together, the synthesis volumes and maps are the first coordinated effort to integrate all available knowledge about the geology and geophysics of a crustal plate on a regional scale. Topics discussed in Volume 1 include stratigraphy, depositional processes, and depositional history; basin synthesis; deep crystal structure; rifting and subsidence theory; geological resources; and environmental hazards. Individual papers were processed separately for the data base.

22788 **Sedimentary cover—North American craton: US: Decade of North American Geology Project.** The Geology of North America, Volume D-2. Sloss, L.L. (ed.) (Northwestern Univ., Evanston, IL (USA). Dept. of Geological Sciences). 620p. The Geological Society of America, Inc., Boulder, CO (USA) (1988). Sponsored by U.S. DOE Energy Research. DOE Contract FG01-84ER13182.

This volume is devoted to the Phanerozoic sedimentary strata covering the largely, but by no means exclusively, crystalline rocks of that part of the North American craton in the United States (exclusive of Alaska). Readers will note that this opening sentence implies constraints of space, time, and lithology on the subject matter dealt with here. The geographic qualifications derive from the organization structure of The Decade of North American Geology, and it only remains to point out that cratonic rocks and their histories are not delimited by national borders – nor by continental margins where these represent the lines of fission of former megacontinents. The qualifications of age and rock type are discussed on later pages, but first it is necessary to raise the question: "What is a craton?" Individual papers were processed separately for the data base.

22789 (DOE/ER/60348–12) **Continental shelf processes affecting the oceanography of the South Atlantic Bight: Progress report, June 1989–May 1990.** Atkinson, L.P. Old Dominion Univ., Norfolk, VA (USA). Dept. of Oceanography. Feb 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER60348. Order Number DE90008439. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

During the past year research activities have focused on analysis and synthesis of existing data from the GALE, FLEX and SPREX experiments and preparation for the WINTER-90 field experiment. The author has also spent some time assisting DOE in planning for the restructuring of the marine program. 8 refs.

22790 (EGG–10617-6062) **Regional Seismic Test Network (RSTN) operations final report.** Harrer, S.J. EG and G Energy Measurements, Inc., Albuquerque, NM (USA). Kirtland Operations. Aug 1989. 103p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (KO–215-89). Order Number DE90008247. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This Regional Seismic Test Network (RSTN) Operations Final Report is a history of the operations of this project. It is intended for those who were directly involved in the RSTN project, as well as for those who are involved in other similar projects. Included is a history of problems experienced at each station, functions performed by the System Control and Receiving Station (SCARS), and the performance of some crucial equipment. 9 refs.

22791 (EGG–10617-6066) **System control and receiving station quarterly report, July–September 1989.** Harrer, S.J. EG and G Energy Measurements, Inc., Albuquerque, NM (USA). Kirtland Operations. Sep 1989. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (KO–019-90). Order Number DE90008248. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This quarterly progress report discusses activities at the Seismic System Control and Receiving Station for July-September 1989. Included is a general description, a monthly summary, monthly data quality summaries, and data quality report. 4 figs., 2 tabs. (KS)

22792 (EGG-M–89247) **Site-specific strong ground motion predictions of A M 7 basin and range normal faulting earthquake in southeastern Idaho.** Wong, I. (Woodward-Clyde Consultants, Oakland, CA (USA)); Silva, W.; Darragh, R.; Stark,

C.; Wright, D.; Jackson, S.; Carpenter, G.; Smith, R. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9005115–1: 4. U.S. conference on earthquake engineering, Palm Springs, CA (USA), 20-24 May 1990). Order Number DE90006983. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Strong earthquake ground motions have been estimated for ten sites at the Idaho National Engineering Laboratory assuming that an event similar to the 1983 M_s 7.3 Borah Peak earthquake occurs along the southern segment of the Lemhi fault. The strong ground motion parameters have been estimated based on a methodology incorporating the Band-Limited-White-Noise ground motion model coupled with Random Vibration Theory. A 16-station seismic attenuation and site response survey utilizing three-component portable digital seismographs was also performed for a five-month period in 1989. Based on strong motion records of the 1983 Borah Peak earthquake and recordings of other regional earthquakes, the seismic attenuation in the shallow crust (κ) and local site response have been evaluated. These data combined with detailed geologic profiles developed for each site based principally on borehole data, were used in the estimation of the strong ground motion parameters. The peak horizontal ground accelerations for individual sites range from approximately 0.15 to 0.40 g at distances of 27 to 11 km. Based on our analysis, the thicker sedimentary interbeds in the basalt section attenuate high frequency ground motions. 22 refs., 5 figs.

22793 (LBL–24915) **FMG, RENUM, LINEL, ELLFMG, ELLP and DIMES: Chain of programs for calculating and analyzing fluid flow through two-dimensional fracture networks: Users manuals and listings.** Billaux, D.; Peterson, J.; Bodea, S.; Long, J. Lawrence Berkeley Lab., CA (USA). 30 Sep 1989. 159p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. Order Number DE90008065. Available from NTIS, PC A07/MF A01; OSTI; INIS.

The purpose of this report is to provide the user with sufficient information to run the programs FMG, RENUM, LINEL, and ELLFMG. A previous report explained the theory and the design of these programs, so that by using the two reports, a thorough understanding of the codes is possible. This report should familiarize the user with program options and modes of operation, input variables, input and output files. Information not strictly needed to run the programs, but useful in understanding their internal structure is provided in appendices. The appendices cover program variables and arrays, subroutine outlines, a short description of each subroutine, and finally listings of codes. The additional information on FMG, RENUM, LINEL, and ELLFMG is in Appendices A, C, E, G respectively, and the listings are in Appendices B, D, F, and H.

22794 (LBL–28279) **Practical aspects of Crosswell tomographic surveys.** Peterson, J.E. Jr.; Majer, E.L.; Tura, A.; Davey, A. Lawrence Berkeley Lab., CA (USA). Oct 1989. 3p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900229–2: International symposium on borehole geophysics for petroleum, hydrogeology, mining and engineering applications, Tucson, AZ (USA), 1-7 Feb 1990). Order Number DE90007758. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Short communication. GEOPHYSICAL SURVEYS/computerized tomography; IMAGE PROCESSING; SEISMIC SURVEYS; DIFFRACTION; WAVE FORMS

22795 (SAND–89-2764C) **Subsurface TE scattering by tunnels using a surface line current.** Shope, S.M. (Sandia Research Associates, Inc., Corrales, NM (USA)); Wayland, J.R.; Lee, D.O. Sandia National Labs., Albuquerque, NM (USA). 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900568–1: IEEE AP-S international symposium and URSI science meeting, Dallas, TX (USA), 7-11 May 1990). Order Number DE90003839. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A new technique for tunnel detection and location has recently been theoretically modeled and experimentally demonstrated. The objective of this research is to develop a general method for remotely detecting the presence of unauthorized tunneling activities using one or more boreholes and a surface source. A line current or dipole-dipole array, positioned on or near the surface of the earth, is used as the TE current source. Subsurface electric and magnetic field measurements are made in a borehole that is situated near a suspected tunnel location. The presence of a tunnel causes subsurface scattering of the field components created by the source. Both the electric and magnetic field strength and phase data is perturbed by the presence of a nearby tunnel. The scattered fields are observed on both sides of the tunnel relative to the source position. 1 fig.

22796 (UCRL–102861) **Southern oscillation in the OSU coupled upper ocean/atmosphere GCM.** Sperber, K.R. (Lawrence Livermore National Lab., CA (USA)); Gates, W.L.; Potter, G.L.; Hameed, S. Lawrence Livermore National Lab., CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8910338–2: 14. annual climate diagnostics workshop, San Diego, CA (USA), 16-20 Oct 1989). Order Number DE90008415. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

With the advent of coupled ocean/atmosphere global climate models it has become possible to study their inherent natural variability. This natural variability arises as a consequence of the encoded physics and dynamics since the only imposed constraint on the simulation is the diurnal and annual cycle of solar radiation. One of the dominant modes of interannual variability is the Southern Oscillation (SO). The Oregon State University coupled upper ocean/atmosphere global climate model has been shown to qualitatively simulate many aspects of the SO. Sea-level pressure (SLP), sea-surface temperature (SST), thermocline layer temperature, surface air temperature, precipitation, and mixed layer currents are among the simulated fields which reproduce SO characteristics. Thus the nature of ocean/atmosphere feedback processes can be investigated. 10 refs., 2 figs.

22797 Geologic map of the surficial deposits of the Topopah Spring quadrangle, Nye County, Nevada. Swadley, W.C.; Hoover, D.L. vp.Geological Survey, Reston, VA (US) (1989).

A geologic map of the surficial deposits of the Topopah Spring quadrangle, Nye County, Nevada is presented.

22798 Geochemistry, isotopic composition, and origin of fluids emanating from mud volcanoes in the Copper River basin, Alaska. Motyka, R.J. (Alaska Div. of Geological and Geophysical Surveys, Juneau (USA)); Poreda, R.J.; Jeffrey, A.W.A. *Geochimica et Cosmochimica Acta (USA),* 53(1): 29-41 (Jan 1989). DOE Contract FG07-84ID12524;AC21-84MC21131.

Analyses of waters and gases from the Copper River basin, Alaska, show marked differences in the fluid chemistries of two groups of mud-volcano saline springs. The Tolsona group discharges Na-Ca rich, HCO_3-SO_4 poor saline waters accompanied by small amounts of CH_4, N_2, and He. Tolsona gases have $^3He/^4He$ ratios of 0.75 to 2.7 (R/R_{atm}), $\delta^{13}C$-CH_4 values of −33 to −22 per mil, and $\delta^{15}N$ values of −1.8 to +1.6 per mil. The Klawasi group discharges Ca poor, Na-HCO_3 rich saline waters with large amounts of CO_2 and $^3He/^4He$ ratios of 2.6 to 4.1 (R/R_{atm}), $\delta^{13}C$-CO_2 values of −4.8 to −3.1 per mil, $\delta^{13}C$-CH_4 values of −23 to −18 per mil, and $\delta^{15}N$ of −3.5. Spring waters are strongly enriched in Li, Na, K, Mg, HCO_3, SO_4, B, SiO_2, As and ^{18}O and strongly depleted in Ca, Sr and deuterium. The differences in fluid chemistry are attributed to the interaction of CO_2 with Tolsona-type formation waters. The CO_2 is thought to be derived from a deep-seated magmatic intrusive and contact decarbonation of limestone beds underlying the Klawasi area.

22799 Significant cenozoic faulting, east margin of the Espanola basin, Rio Grande Rift, New Mexico. Vernon, J.H. (Los Alamos National Lab., NM (USA)); Riecker, R.E. *Geology (USA),* 17(3): 230-233 (Mar 1989).

Tectonic interpretation of the east margin of the Espanola Basin, Rio Grande rift, New Mexico, has been controversial. Previous authors have disagreed as to whether significant faulting defines the boundary between the basin and the Sangre de Cristo Mountains. A more recent geophysical basin transect that suggests no significant faulting and field observation of faceted spurs along the western Sangre de Cristo Mountain front indicating a faulted margin motivate our study. The east margin of the Espanola Basin for

about 37 km north of Santa Fe, New Mexico, is marked by a complex array of significant, late Cenozoic high-angle faults. Locally, three parallel, north-trending, high-angle faults cut Precambrian basement and Tertiary basin-full rocks along the basin margin. Elsewhere along the margin, tilted fault blocks and intersecting faults occur. Fault area, fault attitude with depth, magnitude of fault motion, and timing of fault motion remain uncertain. However, faults studied in detail are 1-2 km long, have minimum dip-slip motion of 33-100 m, and underwent movement during the late Cenozoic. Potentially significant tectonic and seismic hazard implications arise from the possibility of post-150 ka fault motion.

22800 Sodium-calcium ion exchange in the weathering of shales: implications for global weathering budgets. Cerling, T.E. (Univ. of Utah, Salt Lake City (USA)); Pederson, B.L.; Von Damm, K.L. *Geology (USA)*, 17(6): 552-554 (Jun 1989). DOE Contract AC05-84OR21400.

Unpolluted rivers and streams that drain marine shales show an excess of sodium compared to chloride and a deficiency of calcium and magnesium compared to sulfate and alkalinity. This is due in part to cation exchange of sodium for divalent cations on clay minerals. Consideration of the global weathering budget suggest that up to 34% of the sodium in the total dissolved stream load may be due to cation exchange rather than sodium production via silicate dissolution weathering reactions. These results suggest that the weather budgets for sodium and calcium are in need of revision because of the inclusion of cation-exchange processes in the weathering cycle. This implies that silicate dissolution is less important in determining the composition of global river water than was previously thought.

22801 Environmental hazards of pyroclastic flows determined by numerical models. Valentine, G.A. (Los Alamos National Lab., NM (USA)); Wholetz, K.H. *Geology (USA)*, 17(7): 641-644 (Jul 1989).

Numerical solutions of the compressible, multiphase Navier-Stokes equations are applied to conditions appropriate for the development of pyroclastic flows from collapsing Plinian eruption columns. Temporal and spatial variations in horizontal velocity, dynamic pressure, solid volume fraction, and temperature are analyzed for three experiments that model variations in behavior due to differing eruption conditions. Pyroclastic flows display a complex evolution with time and runout distance for the vent. Evolution of flow parameters is most generally manifested by alternating periods of erosion and deposition. Velocities of flow heads decrease and solid concentrations in the flow heads increase with distance from vent. Application of numerical modeling to such phenomena can help in assessing volcanic hazards and pyroclastic transport processes.

22802 Isotopic evidence for paleohydrologic evolution of ground-water flow paths, southern great plains, United States. Dutton, A. (Univ. of Texas, Austin (USA)); Simpkins, W.W. *Geology (USA)*, 17(7): 653-656 (Jul 1989).

A confined aquifer in Triassic Dockum Group sandstone beneath the southern Great Plains was isolated from hypothesized paleorecharge areas in eastern New Mexico by Pleistocene erosion of the Pecos and Canadian river valleys and formation of hydrologic divides. Truncation of the flow system left meteoric water in the confined aquifer with mean δD and $\delta^{18}O$ values that are 17°/oo and 2.0°/oo, respectively, lighter than those in the overlying High Plains aquifer. Thick upper Dockum mudstone retards downward flow from the High Plains aquifer, which has been recharged by isotopically heavy precipitation during the Holocene. Recharge to the confined aquifer occurred at altitudes of 1600 to 2200 m in proximal Dockum sandstone facies since eroded in eastern New Mexico, at a mean temperature 3 C cooler than present temperature across the southern High Plains. Effect of Pleistocene climatic change on isotopic composition of Dockum ground water could be superposed over geomorphologic effects.

22803 Copper and nickel partitioning in iron meteorites. Sutton, S.R. (Brookhaven National Lab., Upton, NY (USA)); Smith, J.V.; Delaney, J.S.; Prinz, M. *Geochimica et Cosmochimica Acta (USA)*, 51(10): 2653-2662 (Oct 1987). DOE Contract AC02-76CH00016.

Trace element analyses using proton induced x-ray emission (PIXE) and synchrotron x-ray fluorescence (SXRF) have been made on metal and troilite from 9 iron meteorites representing 5 geochemical groups. Nickel and copper distribution coefficients D (troilite/metal) vary by factors of 600 and 20, respectively, correlate positively with kamacite band width and correlate negatively with bulk nickel content. Meteorites with bulk Ni < 10% have Cu-enriched troilite ($D_{Cu} > 1$) while those with Ni > 10% have Cu-depleted troilite ($D_{Cu} < 1$). Since magmatic evolution and partial melting will produce Cu-enriched troilite only, the observation of Cu-depleted troilite in Ni-rich meteorites is evidence for subsolidus re-equilibration, a process which reduces D_{Cu} by transfer of Cu to exsolving metal. Elemental redistribution may have played an important role in establishing the present chemical trends in iron meteorites.

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Refer also to citation(s) 22429, 22919, 23064

22804 (AD-A–214725/4/XAB) **MHD (magnetohydrodynamic) slow shocks in coronal and interplanetary space. Final report, 1 June 1986-31 May 1989.** Whang, Y.C. Catholic Univ. of America, Washington, DC (USA). Dept. of Mechanical Engineering. Aug 1989. 34p. Available from NTIS, PC A03/MF A01.

The overall objective of this project is to study shock waves of the solar terrestrial medium in coronal and interplanetary space. This research will enhance our understanding on the propagation of large-amplitude disturbances from the solar corona through the interplanetary space. Work accomplished during the past three years includes: (1) a demonstrating example showing the formation of slow shock pairs associated with CMEs in a coronal environment; (2) a parametric study of slow shocks in the entire domain of a three-dimensional parameter space, the A, theta, Beta-space; (3) the large scale geometry of traveling interplanetary shocks; (4) the transition of slow shocks to fast shocks in the inner solar wind; and (5) the evolution of CME associated shocks and their interplanetary manifestations.

22805 (AD-A–214801/3/XAB) **Study of solar oscillations. Final report, 1 April 1980-31 March 1981.** Hill, H.A. Arizona Univ., Tucson, AZ (USA). Dept. of Physics. 5 Jun 1981. 12p. Available from NTIS, PC A03/MF A01.

Recent observational evidence on solar oscillations is reviewed; this evidence strongly favors the global interpretation for much of the observed spectrum. Implications of these observations for the study of the solar interior and atmosphere are discussed. An observational program and supporting theoretical program are described in which the oscillations are detected via solar-diameter measurements at Santa Catalina Lab. for Experimental Relativity by Astrometry. The main goal of these programs is the classification of the observed modes of oscillation. Results will be used to infer information about the internal rotation of the sun, the depth of the convection zone, and other properties of the internal structure of the sun.

22806 (AD-A–215028/2/XAB) **Solar-cycle effects on trapped energetic particles. Technical report.** Vampola, A.L. Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab. 15 Oct 1989. 47p. (TR–0089(4940-05)-3). Available from NTIS, PC A03/MF A01.

The energetic-particle populations in the earth's magnetosphere, which are the result of geomagnetic activity and, ultimately, are due to solar activity, have a major impact on the operation and survival of spacecraft. Departures from the nominal in solar activity produce requirements for changes from the nominal in the design and operation of spacecraft. If the approaching solar maximum is a robust one, as is indicated by preliminary solar data, the energetic particle population can be expected to be in excess of that predicted by particle models such as AE8 and AP8, since those models include solar-cycle effects based on nominal solar activity. In the event of a robust solar cycle, accelerated degradation of electronics and power systems, increased sensor background effects, and more

frequent operational anomalies may be expected on spacecraft which were designed for a nominal energetic particle population that could be expected based on a robust solar Cycle 22.

22807 (CEA-CONF–9815) **The non-linear universe from 0.01 to 100 Mpc.** Schaeffer, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 34p. (CONF-8808293–: 11. Cracow Summer School, Cracow (Poland), 22-31 Aug 1988). Order Number DE90756365. Available from NTIS (US Sales Only), PC A03/MF A01.

The luminosity function of galaxies and clusters as well as their correlations can be calculated assuming the many-body correlation functions are scale invariant. The same hypothesis leads to predictions of the galaxy counts in cells that are seen to be of the Schechter form and to predictions of the fractal dimension of the galaxy distribution. The latter is found to be bifractal, that is characterized by two dimensions $D=3-\gamma$ in the cluster region, and $D = (3-\gamma)(2+\alpha)$ in the nearly empty regions, α being the Schechter index for the galaxy luminosity function. Finally, the same models lead to predictions for the evolution of the cluster and X-ray luminosity functions, as well as for the Sunyaev-Zeldovich effect due to all virialized clusters, which is found to be large and to produce fluctuations of order 10^{-5} at sub-arc minute scales in the microwave background.

22808 (CONF-8309418–) **An international discussion on research in solar and space physics.** National Research Council, Washington, DC (USA). 1983. 37p. From Workshop on solar and space physics; Hilton Head, SC (USA); 20-23 Sep 1983. Available from NTIS, PC A03/MF A01.

This report is the result of a four-day workshop convened jointly by the U.S. National Academy of Sciences/National Research Council and the European Science Foundation (ESF). Fifty scientists from thirteen nations attended, representing the U.S. Space Science Board (SSB) and the ESF's Space Science Committee (SSC), for the purpose of investigating the prospects for more effective cooperation in research in solar and space physics. Discussions during the workshop concerned: (1) the status of solar and space physics as academic subjects, in order to investigate the potential for the future of these research areas in terms of the training of new scientists; (2) the future plans and programs of National Aeronautics and Space Administration (NASA), European Space Agency (ESA), and several European countries, in order to assess the potential for cooperation in expected research opportunities; and (3) U.S./European cooperation in terms of past successes and problems. Much of the discussion concerned the differences between the U.S. and European systems in the planning of space programs, initiating missions, and selecting and developing experiments. It was recommended that an international solar and space physics program should be established and that it should be constructed from currently planned missions by ESA and NASA.

22809 (INIS-SU–155) **Wind instability as a possible cause of the spiral structure formation in the gaseous subsystem of galaxies with the circular magnetic field.** Gestrin, S.G. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Radioastronomicheskij Inst. 1988. 19p. (In Russian). Order Number DE90618944. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Preprint no.16.

The wind instability as the possible cause of the spiral structure in the gaseous subsystems of galaxies with the circular magnetic field. It is shown that in the presence of sufficiently strong circular magnetic field typical for some galaxies very weak peculiarity on the rotation curve which is provide for the existence of the localized surface mode is required for the development of the wind instability. This peculiarity is the jump of the second derivative from the angular velocity. It is necessary also that magnetic field grow or fall down slower than 1/r with the distance from the galactic centre. In this case the spiral structure arises with the number of arms being defined by the ratio between the rotation velocity near the peculiarity and the Alfven speed in the disc. 12 refs.; 2 figs.

22810 (INIS-SU–156) **Jupiter's drifting decametric bursts with the changing time scale.** Gerasimova, N.N. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Radioastronomicheskij Inst. 1988. 21p. (In Russian). Order Number DE90618870. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Preprint no.18.

The drifting burst class with the changing time scale for each event is selected from the observational data of the Jovian decametric emission obtained with the radiotelescope UTR-2. The burst duration at fixed frequency changes from few seconds (or a fractions of a second) at frequencies f=10-12 MHz to less then 0.02 s (the time constant of the registration) at frequencies f=12-17 MHz. The model in which electron beams streaming from the planet generate plasma natural oscillations at the frequency around the electron gyrofrequency is proposed. Presence of the regular and irregular inhomogeneities of the magnetic field and density could provide both hydrodynamic and kinetic character of the instability during the individual event. This fact leads to the sharp change of the time scales in the limits of one event. 15 refs.; 4 figs.; 2 tabs.

22811 (LA-UR–90-432) **M51's spiral structure.** Howard, S. (Los Alamos National Lab., NM (USA)); Byrd, G.G. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract W-7405-ENG-36. RII8610669. (CONF-891278–1: Astrophysics meeting, Tuscalosa, AL (USA), 3-7 Dec 1989). Order Number DE90007624. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The M51 system (NGC 5194/5195) provides an excellent problem both in spiral structure and in galaxy interactions. We present an analytic study of a computer experiment on the excitation mechanisms for M51's spiral arms and whether or not a halo is important for these mechanisms. This work extends previous numerical studies of the M51 system by including self-gravitation in a two component disk: 'gas' and 'stars', and a dark halo. The analytic study provides two new observational constraints: the time ($\approx$70-84 million years ago) and position angle of perigalacticon (300°). By using these constraints and a simple conic approximation, the search for the companion's possible orbit is greatly simplified. This requires fewer N-body simulations than a fully self-gravitating orbit search. 8 refs., 4 figs.

22812 (N–90-13297) **Evolution of domain walls in the early universe. Ph.D. Thesis - Chicago Univ.** Kawano, L. Fermi National Accelerator Lab., Batavia, IL (USA). Oct 1989. 30p. (NASA-CR–186076;NAS–1.26:186076;FERMILAB-PUB–89/208-A). Available from NTIS, PC A03/MF A01.

The evolution of domain walls in the early universe is studied via 2-D computer simulation. The walls are initially configured on a triangular lattice and then released from the lattice, their evolution driven by wall curvature and by the universal expansion. The walls attain an average velocity of about 0.3c and their surface area per volume (as measured in comoving coordinates) goes down with a slope of -1 with respect to conformal time, regardless of whether the universe is matter or radiation dominated. The additional influence of vacuum pressure causes the energy density to fall away from this slope and steepen, thus allowing a situation in which domain walls can constitute a significant portion of the energy density of the universe without provoking an unacceptably large perturbation upon the microwave background.

22813 (N–90-14076) **Observational physics of mirror world.** Khlopov, M.YA.; Beskin, G.M.; Bochkarev, N.E.; Pustilnik, L.A.; Pustilnik, S.A. AN SSSR, Moscow (USSR). Sep 1989. 28p. (NASA-CR–185923;NAS–1.26:185923;FERMILAB-PUB–89/193-A). Available from NTIS, PC A03/MF A01.

The existence of the whole world of shadow particles, interacting with each other and having no mutual interactions with ordinary particles except gravity is a specific feature of modern superstring models, being considered as models of the theory of everything. The presence of shadow particles is the necessary condition in the superstring models, providing compensation of the asymmetry of left and right chirality states of ordinary particles. If compactification of additional dimensions retains the symmetry of left and right states, shadow world turns to be the mirror one, with particles and fields having properties strictly symmetrical to the ones of corresponding ordinary particles and fields. Owing to the strict symmetry of physical laws for ordinary and mirror particles, the analysis of

cosmological evolution of mirror matter provides rather definite conclusions on possible effects of mirror particles in the universe. A general qualitative discussion of possible astronomical impact of mirror matter is given, in order to make as wide as possible astronomical observational searches for the effects of mirror world, being the unique way to test the existence of mirror partners of ordinary particles in the Nature.

22814 (N–90-14154) **An implementation plan for priorities in solar-system space physics.** Krimigis, S.M.; Athay, R.G.; Baker, D.; Fisk, L.A.; Fredricks, R.W.; Harvey, J.W.; Jokipii, J.R.; Kivelson, M.; Mendillo, M.; Nagy, A.F. National Research Council, Washington, DC (USA). 1985. 83p. (NASA-CR–185375;NAS–1.26:185375). Available from NTIS, PC A05/MF A01.

The scientific objectives and implementation plans and priorities of the Space Science Board in areas of solar physics, heliospheric physics, magnetospheric physics, upper atmosphere physics, solar-terrestrial coupling, and comparative planetary studies are discussed and recommended programs are summarized. Accomplishments of Skylab, Solar Maximum Mission, Nimbus-7, and 11 other programs are highlighted. Detailed mission plans in areas of solar and heliospheric physics, plasma physics, and upper atmospheric physics are also described.

22815 (N–90-14156) **Further observations of rotationally excited far infrared OH16 and OH18 emission in Orion-KL: Tighter constraints on the nature of the emitting region.** Melnick, G.J.; Stacey, G.J.; Genzel, R.; Lugten, J.B.; Poglitsch, A. Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.). Jul 1989. 33p. (NASA-CR–186004;NAS–1.26:186004;MPE-PREPRINT–156;ETN–89-95858). Available from NTIS, PC A03/MF A01.

The Orion-KL region, within 1 arc minute, is observed. The rotational cross ladder (53.351 microns) and rotational ground state (120.1719 microns) transitions are studied. It is shown that these lines exhibit a P-Cygni profile and unambiguously show that the OH gas is expanding out from the central BN-KL infrared cluster. The OH-16 rotational ground state transition (119.234 microns) is velocity resolved and it is found that its intrinsic full width at half maximum is 75 km/s. The line fluxes and line profiles are modeled and it is shown that no single temperature and density component can reproduce the data. Rather, the best fit to the data requires emission from three main components of the gas: post shocked gas with the profiles of temperature, density, and OH abundance; a high density component to the cool post shocked region; and the plateau region.

22816 (N–90-14160) **The winds of high luminosity late-type bright stars. Final report, 15 June 1986-14 June 1989.** Stencel, R.E.; Carpenter, K.G. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. 9p. (NASA-CR–182961;NAS–1.26:182961). Available from NTIS, PC A02/MF A01.

The occurrence and characteristics of the Fe II line asymmetries were studied to determine the radial dependence of the wind velocity for each star. The dependence of the Fe II profiles on spectral type and luminosity class and thus the variation of the velocity fields with stellar type was also investigated. This allows the generality of the results reported for alpha Ori by Carpenter (1984b) to be judged. In addition, new atomic data was used along with observations of the C II (UV 0.01) multiplet to estimate N(sub e) in the stellar winds. Measures of relative Fe II fluxes can be used in a probability-of-escape model to determine the opacity and hydrogen column density versus height in the chromosphere of each star. Finally, analysis of the fluorescent Fe II lines (pumped by Ly alpha) near 2507 A will yield estimates of the intrinsic stellar Ly alpha flux that cannot be measured directly because of interstellar and circumstellar absorption. One important goal of the effort was to acquire high resolution spectra of the whole 2300 to 3200 A region of 13 luminous K and M stars as a data base that will be enormously valuable in planning observations with the Hubble Space Telescope High Resolution Spectrograph. It is also proposed to follow up the recent discovery of significant variations in the Fe II chromospheric emission line profiles from the M-giant Gamma Cru for the purpose of determining the underlying cause of the variations.

22817 (N–90-14163) **Archival research on absorption lines in violently star-forming galaxies.** Gallagher, J.S. Lowell Observatory, Flagstaff, AZ (USA). Planetary Research Center. Sep 1989. 7p. (NASA-CR–185960;NAS–1.26:185960). Available from NTIS, PC A02/MF A01.

A computerized analysis of a starburst model is discussed. The model proposes that the absorption line equivalent width should scale with the level of star forming activity. Archival International Ultraviolet Explorer (IUE) data on IUE spectra of luminous blue galaxies were compared with previous IUE observations of extragalactic HII regions and low luminosity galaxies. The comparisons are summarized and causes for offsets are discussed.

22818 (N–90-14167) **Presented at the International Nuclear Physics Conference, Sao Paulo, Brazil, 20-26 August 1989.** Schramm, D.N. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 13p. (NASA-CR–186166;NAS–1.26:186166;FERMILAB-CONF–89/254-A: International nuclear physics and cosmology conference, Sao Paulo (Brazil), 20-26 Aug 1989; CONF-890826–). Available from NTIS, PC A03/MF A01.

Nuclear physics has provided one of two critical observational tests of all Big Bang cosmology, namely Big Bang Nucleosynthesis. Furthermore, this same nuclear physics input enables a prediction to be made about one of the most fundamental physics questions of all, the number of elementary particle families. The standard Big Bang Nucleosynthesis arguments are reviewed. The primordial He abundance is inferred from He-C and He-N and He-O correlations. The strengthened Li constraint as well as D-2 plus He-3 are used to limit the baryon density. This limit is the key argument behind the need for non-baryonic dark matter. The allowed number of neutrino families, N(nu), is delineated using the new neutron lifetime value of tau(n) = 890 + or - 4s (tau(1/2) = 10.3 min). The formal statistical result is N(nu) = 2.6 + or - 0.3 (1 sigma), providing a reasonable fit (1.3 sigma) to three families but making a fourth light (m(nu) less than or equal to 10 MeV) neutrino family exceedly unlikely (approx. greater than 4.7 sigma). It is also shown that uncertainties induced by postulating a first-order quark-baryon phase transition do not seriously affect the conclusions.

22819 (N–90-14168) **Big Bang nucleosynthesis and the quark-hadron transition.** Kurki-suonio, H.; Matzner, R.A.; Olive, K.A.; Schramm, D.N. Drexel Univ., Philadelphia, PA (USA). Dec 1989. 21p. (NASA-CR–186169;NAS–1.26:186169;FERMILAB-PUB–89/252-A). Available from NTIS, PC A03/MF A01.

An examination and brief review is made of the effects of quark-hadron transistion induced fluctuations on Big Bang nucleosynthesis. It is shown that cosmologically critical densities in baryons are difficult to reconcile with observation, but the traditional baryon density constraints from homogeneous calculations might be loosened by as much as 50 percent, to 0.3 of critical density, and the limit on the number of neutrino flavors remains about N(sub nu) is less than or approximately 4. To achieve baryon densities of greater than or approximately 0.3 of critical density would require initial density contrasts R much greater than 10(exp 3), whereas the simplest models for the transition seem to restrict R to less than approximately 10(exp 2).

22820 (N–90-14176) **Analysis of coordinated observations of a giant stellar flare. Final Technical report, 1 March 1988-31 August 1989.** Lambert, D.L. Texas Univ., Austin, TX (USA). Oct 1989. 8p. (NASA-CR–185961;NAS–1.26:185961). Available from NTIS, PC A02/MF A01.

Multi-wavelength observations of a giant flare on the star AD Leo were obtained with the 2.1 m and 0.9 m telescopes at McDonald Observatory and the International Ultraviolet Explorer satellite. The quality, spectral coverage, and time resolution of the data represented a major improvement over any published stellar flare data. Two theoretical, quantitative flare models were developed. Combining the models, the chromospheric emission model predictions in the hydrogen Balmer lines, Da II K, Mg II h + k and the optical continuum were compared to the observations, with the result that much of the gradual phase flare emission could be produced by the x ray and conductive heated atmospheres. The models lend insight into the impulsive phase flare emission, but do not reproduce it. Soft x ray and conductive heating of the chromosphere is a natural consequence of the coronal temperatures that have been

observed during the gradual phase of flares on the sun and on M dwarf stars. The improved flare observations and quantitative flare models presented here show that these heating mechanisms can produce atmospheres whose emission matches many of the observed stellar flare features.

22821 (N–90-14178) **Shear-induced inflation of coronal magnetic fields.** Klimchuk, J.A. Stanford Univ., CA (USA). Aug 1989. 40p. (NASA-CR–186103;NAS–1.26:186103;CSSA-ASTRO–89-11). Available from NTIS, PC A03/MF A01.

Using numerical models of force-free magnetic fields, the shearing of footprints in arcade geometries leading to an inflation of the coronal magnetic field was examined. For each of the shear profiles considered, all of the field lines become elevated compared with the potential field. This includes cases where the shear is concentrated well away from the arcade axis, such that B(sub z), the component of field parallel to the axis, increases outward to produce an inward B(sub z)squared/8 pi magnetic pressure gradient force. These results contrast with an earlier claim, shown to be incorrect, that field lines can sometimes become depressed as a result of shear. It is conjectured that an inflation of the entire field will always result from the shearing of simple arcade configurations. These results have implications for prominence formation, the interplanetary magnetic flux, and possibly also coronal holes.

22822 (N–90-14998) **Abstracts for the 52nd Annual Meeting of the Meteoritical Society.** Lunar and Planetary Inst., Houston, TX (USA). 1989. 337p. (NASA-CR–186160;NAS–1.26:186160;LPI-CONTRIB–712:CONF-8907185–: 52. annual meeting of the meteoritical society, Vienna (Australia), 31 Jul - 4 aug 1989). Available from NTIS, PC A15/MF A02.

Various topics in meteorology are discussed. These topics include chondrites, chondrule, iron and other minerals, impact cratering, lunar studies, early earth and early solar system processes, rare gases and cosmic dust.

22823 (N–90-15004) **Meteoritic basalts. Final report, 1986-1989.** Treiman, A.H. Boston Univ., MA (USA). Oct 1989. 27p. (NASA-CR–185949;NAS–1.26:185949). Available from NTIS, PC A03/MF A01.

The objectives were to: explain the abundances of siderophile elements in the SNC meteorite suite, of putative Martian origin; discover the magmatic origins and possibly magma compositions behind the Nakhla meteorite, one of the SNC meteorites; and a re-evaluation of the petrology of Angra dos Reis, a unique meteorite linked to the earliest planetary bodies of the solar nebula. A re-evaluation of its petrography showed that the accepted scenario for its origin, as a cumulate igneous rock, was not consistent with the meteorite's textures (Treiman). More likely is that the meteorite represents a prophyritic igneous rock, originally with magma dominant. Studies of the Nakhla meteorite, of possible Martian origin, although difficult, were successful. It became necessary to reject the basic categorization of Nakhla: that is was a cumulate igneous rock. Detailed studies of the chemical zoning of Nakhlas' minerals, coupled with the failure of experimental studies to yield expected results, forced the conclusion that Nakhla is not a cumulate rock in the usual sense: a rock composed of igneous crystals and intercrystal magma. Study of the siderophile element abundances in the SNC meteorite groups involved trying to find reasonable core formation processes and parameters that would reproduce the observed abundances. Modelling was successful, and delimited a range of models which overlap with those reasonable from geophysical constraints.

22824 (N–90-15036) **The solar activity measurements experiments (SAMEX) for improved scientific understanding of solar activity.** National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. 1989. 27p. (NASA-TM–100372;NAS–1.15:100372). Available from NTIS, PC A03/MF A01.

Original contains color illustrations.

The Solar Activity Measurements Experiments (SAMEX) mission is described. It is designed to provide a look at the interactions of magnetic fields and plasmas that create flares and other explosive events on the sun in an effort to understand solar activity and the nature of the solar magnetic field. The need for this mission, the instruments to be used, and the expected benefits of SAMEX are discussed.

22825 (PB–90-855305/XAB) **Allende meteorite: Cosmic rosetta stone. September 1972-November 1989 (Citations from the International Aerospace Abstracts data base). Report for September 1972-November 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 89p. Available from NTISPC N01/MF N01.

U.S. sales only.

This bibliography contains citations concerning the Allende meteorite. This carbonaceous chondrite has been the source of numerous, diverse inclusions. Structural and chemical analyses of these inclusions have aided in cosmological studies of the age of the solar system. Analytical techniques for many elements and minerals, and the interpretation of the results obtained, are discussed. This meteorite has provided information on the formation of complex chemical species and structures during the formation of the solar system. Allende is one of the most studied carbonaceous chondritic meteorites and is, therefore, one of the most important sources of information on the early solar system. (Contains 190 citations fully indexed and including a title list.)

22826 (RAL–89-098) **Use of Al XII and Mg XI lines as solar plasma diagnostics.** Bromage, B.J.I. (Rutherford Appleton Lab., Chilton (UK)); Phillips, K.J.H.; Keenan, F.P.; McCann, S.M. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 16p. Order Number DE90618845. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We present three sets of observations of n=1 to n=2 lines due to helium-like aluminium (Al XII), made during two solar flares (25 August, 1980 and 19 October, 1986), using the X-ray Polychromator on satellite. The observed temperature-sensitive line ratio G is shown to be consistent with previously observed close-coupling calculations, although the ratio R, which is both temperature and density-sensitive for lower-Z elements, is not sufficiently well determined from these data to say more than that the observed values of R are not inconsistent with the theoretical calculations. This region of the spectrum also includes the helium-like magnesium (Mg XI) 1^1S-3^1P line, and it is shown that the ratio of this line to the Al XII resonance (1^1S-2^1P) line is a more sensitive indicator of electron temperature than are the Al XII G and R ratios. We demonstrate that the three ratios may be used together in order to derive values of emission measure, electron temperature and electron density during these flares. (author).

22827 (RAL–89-102) **Proceedings of the second workshop on thermal-non-thermal interactions in solar flares [TNT-II]: Held at Somerville College, University of Oxford, England on April 10 - 14, 1989 and arranged by Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., England.** Phillips, K.J.H. (ed.). Rutherford Appleton Lab., Chilton (UK). Sep 1989. 84p. (CONF-8804323–: 2. workshop on thermal-non-thermal interactions in solar flares, Oxford (UK), 10-14 Apr 1988). Order Number DE90618846. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The Second Workshop on the theme of Thermal-Non-thermal Interactions in Solar Flares (TNT-II) was held at Somerville College, University of Oxford, England, during the week of April 10-14, 1989. The keynote address, gave a view of the problems still outstanding with regard to soft and hard X-ray observations of flares. The gathering broke up into four subgroups. The subjects under discussion were: large-scale magnetic field phenomena, flare dynamics, energy release and deposition, and global energy balance. (author).

22828 (RAL–89-102, pp. 1.1-1.19) **Large scale magnetic field phenomena.** Harrison, R.A. (Rutherford Appleton Lab., Chilton (UK)); Bentley, R.D.; Brosius, J. Rutherford Appleton Lab., Chilton (UK). Sep 1989. (CONF-8804323–: 2. workshop on thermal-non-thermal interactions in solar flares, Oxford (UK), 10-14 Apr 1988). In *Proceedings of the second workshop on thermal-non-thermal interactions in solar flares [TNT-II]: Held at Somerville College, University of Oxford, England on April 10 - 14, 1989 and arranged by Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., England.* Order Number DE90618846. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This study group had interests ranging from coronal mass ejections and magnetic modelling to active region heating and post-flare loops. Two main areas of discussion were concerned with the results from two major observing campaigns, namely the Coronal Mass Ejection Onset Programme (CMEOP) and the Coronal Magnetic Structures Observing Campaign (CoMStOC), and several theoretical experts were on hand to address the consequences of these programmes. The following report is divided into three sections: Coronal Mass Ejections; Large Scale Coronal Magnetic Fields and Flare Activity in Relation to Coronal Magnetic Fields. (author).

22829 (RAL–89-102, pp. 2.1-2.25) **Flare dynamics.** Zarro, D. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center); Alexander, D.; Fludra, A. Rutherford Appleton Lab., Chilton (UK). Sep 1989. (CONF-8804323–: 2. workshop on thermal-non-thermal interactions in solar flares, Oxford (UK), 10-14 Apr 1988). In *Proceedings of the second workshop on thermal-non-thermal interactions in solar flares [TNT-II]: Held at Somerville College, University of Oxford, England on April 10 - 14, 1989 and arranged by Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., England.* Order Number DE90618846. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This report presented by Group 2 of the Second Workshop of Thermal-Non-thermal Interactions in Solar Flares, summarizes the discussions into a series of questions covering such areas as the relationship between flare heating and chromospheric evaporation, the nature of flare heating mechanisms and excess broadening during the impulsive and gradual decay phases of flares. (UK).

22830 (RAL–89-102, pp. 3.1-3.26) **Flare energy release and deposition.** Holman, G. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center); Benka, S.; De La Beaujardiere, J. Rutherford Appleton Lab., Chilton (UK). Sep 1989. (CONF-8804323–: 2. workshop on thermal-non-thermal interactions in solar flares, Oxford (UK), 10-14 Apr 1988). In *Proceedings of the second workshop on thermal-non-thermal interactions in solar flares [TNT-II]: Held at Somerville College, University of Oxford, England on April 10 - 14, 1989 and arranged by Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., England.* Order Number DE90618846. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Group 3 of the Second Workshop of Thermal-Non-thermal Interactions in Solar Flares concentrated their discussions on flare energy release and deposition. Presentations on electron energization, proton acceleration, mirroring, scattering, and precipitation and energy deposition. Each topic is briefly explored in this report. (UK).

22831 (RAL–89-102, pp. 4.1-4.14) **The global energy balance in flares.** Simnett, G.M. (Birmingham Univ. (UK)); Linford, G.A.; Metcalf, T.R. Rutherford Appleton Lab., Chilton (UK). Sep 1989. (CONF-8804323–: 2. workshop on thermal-non-thermal interactions in solar flares, Oxford (UK), 10-14 Apr 1988). In *Proceedings of the second workshop on thermal-non-thermal interactions in solar flares [TNT-II]: Held at Somerville College, University of Oxford, England on April 10 - 14, 1989 and arranged by Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., England.* Order Number DE90618846. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

A key issue in flare energetics is the mechanism through which the energy is transferred from the coronal magnetic field to the heated flare plasma. Recently it has become an issue as to whether non-thermal, mildly-relativistic electrons of non-thermal, but low energy ions dominate this process. We first review briefly the nature of the problem; then we discuss some relevant, key observations; and finally we outline three specific research areas where future developments may provide definitive answers to questions of global flare energetics. (author).

22832 (UCRL–98567) **Mars in this century: The Olympia Project.** Hyde, R.A.; Ishikawa, M.Y.; Wood, L.L. Lawrence Livermore National Lab., CA (USA). [1988]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8804105–2: 4. national space symposium, Colorado Springs, CO (USA), 12-15 Apr 1988). Order Number DE90008356. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Manned exploration of the inner solar system — typified by a manned expedition to Mars — this side of the indefinite future involves fitting a technical peg into the political hole. If Apollo-level resources are assumed unavailable for such exploratory programs, then non-Apollo means and methods must be employed, involving greater technical and human risks, or else such exploration must be deferred indefinitely. Sketched here is an example of such a relatively high-risk alternative, one which could land men on Mars in the next decade, and return them to earth. Two of its key features are a teleoperated rocket fuel-generating facility on the lunar surface and an interplanetary mission-staging space station at L_4, which would serve to enable a continuing solar system exploratory program, with annual mission commencements to points as distant as the Jovian moons. The estimated cost-to-execute this infrastructure-building manned Mars mission is $3 billion, with follow-on missions estimated to cost no more than $1 billion each. 3 figs., 2 tabs.

22833 The Explorer program for astronomy and astrophysics. Savage, B.D.; Becklin, E.E.; Cassinelli, J.P.; Dupree, A.K.; Elliot, J.L.; Hoffmann, W.F.; Hudson, H.S.; Jura, M.; Kurfess, J.; Murray, S.S. 60p. National Academy of Sciences - National Research Council, Washington, DC (US) (1986).

Original contains color illustrations.

This report was prepared to provide NASA with a strategy for proceeding with Explorer-class programs for research in space astronomy and astrophysics. The role of Explorers in astronomy and astrophysics and their past accomplishments are discussed, as are current and future astronomy and astrophysics Explorers. Specific cost needs for an effective Explorer program are considered.

22834 Model atmospheres for K and M giants. Brown, J.A. (Indiana Univ., Bloomington (USA)); Johnson, H.R.; Cutright, L.C.; Alexander, D.R.; Sharp, C.M. *Astrophysical Journal, Supplement Series (USA),* 71: 623-646 (Nov 1989).

To aid in the interpretations of observations of K and M giant stars, model atmospheres have been calculated, covering the range in effective temperature between 3000 and 4000 K and in surface gravity-log g between 0.0 and 2.0. These models are computed under the usual assumptions of hydrostatic equilibrium, constancy of total (radiative plus convective) flux, and LTE in plane-parallel, horizontally homogeneous geometry. A significant development in these models is the incorporation of an opacity-sampled treatment of absorption by water vapor, which becomes dominant at lower temperatures. The thermal structure and scaling properties of the models are discussed, as are the effects of certain composition changes expected in the course of stellar evolution. 51 refs.

22835 Dynamics of flare-driven chromospheric condensations. Fisher, G.H. (Hawaii Univ., Honolulu (USA)). *Astrophysical Journal (USA),* 346: 1019-1029 (Nov 1989).

A general model of chromospheric condensation dynamics is developed under the assumption of sudden impulsive-phase flare energy release. The basic equation of motion for the downward-moving condensation is derived from the momentum equation and from general features seen in numerical simulations. This equation is solved for a number of different cases. The 'lifetime' of condensation and the time for the velocity to drop to half its peak value are computed. The peak downflow speed is examined as a function of the flare energy flux, and comparisons are made between downflow speeds predicted by both thick-target 'explosive evaporation' and evaporation driven conductively. 43 refs.

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Refer also to citation(s) 22796, 22806, 23086, 23172

22836 (AD-A–212186/1/XAB) **Satellite observations of the O I 1304, 1356 and 1641 A dayglow and the abundance of atomic oxygen in the thermosphere.** Conway, R.R.; Meier, R.R.; Huffman, R.E. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1988. 12p. (GL-TR–89-0240). Available from NTIS, PC A03/MF A01.

Pub. in Planetary and Space Science, Vol. 36, No. 10, 963-973(1988).

The far ultraviolet spectrometer experiment on the S3-4 satellite made nadir-viewing observations of the atomic oxygen dayglow during the spring of 1978. Comparison of 27 orbits of OI 1304A (2p-3S), 1356 A (3p-3S), and 1641 A (1D-3S) intensities shows important orbit-to-orbit variations. For four selected orbits of data, airglow intensities were computed using the O abundance predicted by the MSIS-83 model atmosphere for the appropriate geophysical conditions. In general, the MIS-83 model atmosphere reproduces the airglow rather well. To match the absolute magnitude of the airglow, the computed photoelectron flux was increased by 40%, also the observed 1641/1304 intensity ratio required a branching ratio of 2.4×10^{-6}. Reductions in the airglow during geomagnetically disturbed conditions suggest decreases in the O concentration which can be observed remotely.

22837 (AD-A-214461/6/XAB) **Plasma transport through the dayside cleft: A source of ionization patches in the polar cap.** Foster, J.C. Massachusetts Inst. of Tech., Cambridge, MA (USA). 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Electromagnetic Coupling in the Polar Clefts and Caps, 343-354(1989).

Rapid sunward convection from the post-noon ionosphere carries high-density solar-produced F-region plasma through the dayside cleft and into the polar cap. This plasma is swept through the noontime cleft and enters the polar cap as a tongue of ionization which delineates the convection trajectory and its dynamics and provides the source for enhanced F-region plasmas and their effects which are observed at high polar latitudes away from noon.

22838 (AD-A-214541/5/XAB) **Two-dimensional mapping of dayside convection.** Foster, J.C.; Yeh, H.C.; Holt, J.M.; Evans, D.S. Massachusetts Inst. of Tech., Cambridge, MA (USA). 1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Electromagnetic Coupling in the Polar Clefts and Caps, 115-125(1989).

Millstone Hill radar azimuth scans were used to map the large-scale features of the ionospheric convection pattern in the vicinity of the cusp and cleft. Each scan covers 5 hours of MLT and 20 deg of invariant latitude with 30 minute temporal resolution Individual snapshots of the convection pattern for disturbed conditions on 31 January 1982 span the entire region of convection convergence near noon and compare favorably with average model representations of the dayside region. The characteristic features of ion and electron precipitation observed during satellite overflights of the radar field of view are used to identify the cusp and cleft and to relate the location of these magnetospheric features to the pattern of ionospheric convection electric field. Cusp precipitation is seen at 70 deg lat. and 09 MLT at the sunward/anti-sunward convection reversal immediately after a sudden turning of interplanetary magnetic field (IMF) B sub y from -5 nT to +5 nT while IMF B sub z was -10 nT.

22839 (AD-A-215035/7/XAB) **Center of excellence in theoretical geoplasma research. Final report, 1 October 1986-30 September 1989.** Chang, T. Massachusetts Inst. of Tech., Cambridge, MA (USA). Center for Space Research. 10 Nov 1989. 79p. Available from NTIS, PC A05/MF A01.

Partial contents include: Transverse Acceleration and Heating of Ionospheric Ions and the Formation of Ion conics; Transverse Heating of Ionospheric Ions Along Auroral Field Lines; Acceleration of Ionospheric Ions by Lower-Hybrid Waves in the Discrete Auroral Region; Two-Dimensional Particle-in-cell Plasma Simulation of High-Latitude Lower-Hybrid Turbulence and Charged-Particle Acceleration; Studies of Inhomogeneous Plasma Turbulence in the Auroral Region; A Kinetic Treatment of the Nonclassical Polar Wind; Double-Layer Formation and Ion-Hole Theory along Auroral Field Lines; Flux-Transfer Events and Ionosphere-Magnetosphere Coupling; Auroral Kilometric Radiation and Relativistic Magnetized Anisotropic Plasmas; Plasma Radiations in the Low-Altitude Ionosphere due to Moving Conducting Objects; Gyroresonance-Generated Ion conic Populations; Low-altitude Transverse Ion Acceleration; and Counterstreaming Electrons.

22840 (DOE/RL/10355--T1) **Atmospheric CO_2 abundance: An archival study of spectroscopic data: [Final report].** Brault, J. (National Optical Astronomy Observatories, Tucson, AZ (USA)); Stokes, G. National Optical Astronomy Observatories, Tucson, AZ (USA). [1985]. 15p. Sponsored by U.S. DOE Nuclear Energy; National Science Foundation. DOE Contract AI06-82RL10355. Order Number DE90008472. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This research task consisted of obtaining spectra with the McMath telescope and Fourier transform spectrometer as part of a program funded by the Department of Energy to evaluate solar spectra as a source of data on atmospheric abundances.

22841 (RAL--89-086) **Magnetospheric plasma physics.** Bingham, R. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 75p. Order Number DE90619481. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The discovery of the earth's radiation belts in 1957 by Van Allen marked the beginning of what is now known as magnetospheric physics. In this study of plasma physics in the magnetosphere, we shall take the magnetosphere to be that part of the earth's ionized atmosphere which is formed by the interaction of the solar wind with the earth's dipole-like magnetic field. It extends from approximately 100km above the earth's surface where the proton-neutral atom collision frequency is equal to the proton gyrofrequency to about ten earth radii ($R_E \approx 6380$km) in the sunward direction and to several hundred earth radii in the anti-sunward direction. The collision dominated region is called the ionosphere and is sometimes considered separate from the collisionless plasma region. In the ionosphere ion-neutral collisions are dominant and one may think of the ionosphere as a frictional boundary layer $\approx$ 1000km thick. Other planets are also considered. (author).

22842 **Auroral breakup during substorm onsets.** Rothwell, P.L. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)); Silevitch, M.B.; Falthammar, C.G. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report their development of a model for auroral breakup that consists of two coupled circuits, one east-west, the other north-south that connect the ionosphere and the magnetosphere. It was found that narrow arcs formed at lower L-shells were the most unstable to poleward expansion. In this paper, they make the model more realistic by defining the magnetospheric electric field and current as produced by the dipolar collapse of the stretched magnetic field lines. They use the parameterized magnetic field model. Preliminary results indicate that the collapse of a moderately stretched field configuration over the period of a couple of minutes could induce a westward magnetospheric electric field of 2-10 mv/m at geosynchronous.

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Refer also to citation(s) 21570, 22193, 22225, 22230, 22320, 22354, 22374, 22375, 22448, 22494, 22762, 22950, 22969, 22970, 22974, 23080, 23181

22843 (AD-A-214656/1/XAB) **La Jolla Institute workshop on novel ion sources and their applications, held in La Jolla California on August 3-4, 1981.** Jorna, S. La Jolla Inst., CA (USA). Aug 1981. 64p. (LJI-R--81-146). Available from NTIS, PC A04/MF A01.

Availability: Document partially illegible.

Experts discussed recent research in high-brightness ion sources with possible applications of importance to DoD. Topics presented included: an overview of the definitions of fundamental concepts used to characterize ion beams; capillaritrons in which a gas at high pressure (several hundred torr) is forced through a conducting capillary kept at a potential of about 10 kV with respect to an annular anode – (Ions are produced from the plasma near the tip of the capillary by a process not completely understood); Liquid-Metal Ion (LMI) sources; Gas-phase field ion sources; Negative sources; Field-emission ion sources; Propagation of intense charge-neutral

ion beams in magnetic fields; Thermionic ion sources; and Sputtering.

22844 (AD-A–214983/9/XAB) **Radiative properties of UO^+. Technical report, 15 April 1988-15 April 1989.** Michels, H.H. United Technologies Research Center, East Hartford, CT (USA). 1 Dec 1989. 25p. Available from NTIS, PC A03/MF A01.

An analysis of the low-lying electronic states of UO(+) was undertaken. Oscillator strengths were calculated for thirteen (13) transitions: 1 4I-1 4K, 14I-3 4H, 1 4I-2 4H, 1 4I-1 4H, 1 4I-2 4I, 1 4I-1 6H, 1 4I-3 4I, 1 4H-2 4I, 1 4H-2 4H, 1 4H-1 4K, 1 4H-1 6H, 1 4H,-3 4H, and 1 4H-3 4I. Since the density of electronic states of UO^+ is large above 2.0 eV, we predict that strong solar pumping followed by both LWIR and visible radiation should occur for this system.

22845 (AD-A–215009/2/XAB) **Effect of correlation on the mean excitation energy of beryllium.** Sabin, J.R. Florida Univ., Gainesville, FL (USA). 1 Jun 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Physical Revies A, Vol. 39, No. 11, 5565-5571(1 Jun 1989).

Using the polarization-propagator formalism, the dipole-oscillator-strength distribution for Be has been calculated. Comparison of correlated with Hartree-Fock results shows that inclusion of correlation is very important for calculation of properties of the dipole-oscillator-strength distribution. In particular, IO is calculated to be 43.6 eV, some 12% higher than previously reported.

22846 (BNL–43835) **Density limitation on focusing of ground state cold H° beams.** Hershcovitch, A. Brookhaven National Lab., Upton, NY (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900289–1: International workshop on the polarized ion sources and polarized gas jets, Tsukuba-Shi (Japan), 12-17 Feb 1990). Order Number DE90007673. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Based on recent experimental data regarding H°-H° scattering at low temperatures, limits on achievable $\vec{H}^\circ$ density are shown to be substantially lower than what was previously thought. Upper density limit due to the requirement that the mean free path in the spin selection magnet must exceed the magnet size is an order of magnitude lower as a consequence of much larger collisional cross sections than those previously assumed. Additionally, transit time effects set even lower limits on densities that can be practically reached with slow beams. 22 refs.

22847 (CEA-CONF–9460) **Barium atoms and N20 molecular agregates reaction.** Visticot, J.P.; Mestdagh, J.M.; Alcaraz, C.; Cuvellier, J.; Berlande, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). Jun 1988. 2p. (In French). (CONF-8806459–: 21. national colloquium on physics of atom and electron collisions, Caen (France), 21-24 Jun 1988). Order Number DE90756350. Available from NTIS (US Sales Only), PC A02/MF A01.

The collisions between a barium atom and N20 molecular agregates are studied, for a better understanding of the solvatation part in a chemical reaction. The experiments are carried out in a crossed molecular beam device. The light coming from the collision zone is scattered, and analysed by means of a photon detector. A time-of-flight technique is applied in the investigation of the beam's polymer concentration. The results show a nearly negligible chemiluminescent effect in the reaction between barium and N20 polymer. A solvated BaO formation mechanism is proposed to justify the experimental results.

22848 (CEA-CONF–9660) **Ionization and ions pair formation in $He(n^1P)$ thermal collisions in the Rydberg + molecules low states.** Pesnelle, A.; Ronge, C.; Perdrix, M.; Watel, G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). Jun 1988. 2p. (In French). (CONF-8806459–: 21. national colloquium on physics of atom and electron collisions, Caen (France), 21-24 Jun 1988). Order Number DE90756352. Available from NTIS (US Sales Only), PC A02/MF A01.

The application limits of the free electron model are tested. Experiments on polar molecules and on molecules of high electronical affinity are effectuated. The experiments are carried out in a three crossed beam geometry: a $He(2^1S, 2^3S)$ metastable atom beam, a continuous and monomode laser UV beam (316 nm), and a gas target beam. The main results are: high cross sections are observed on NH3, SO2 and C3H6O; the σ"exp" behavior, as a function of v_r, is v_r^{-2}; a monotone σ"exp" (v_r) behavior is observed for SF6 and NO2. The experimental data can not be justified by means of the free electron model.

22849 (CEA-CONF–9661) **Production of autoionizing di-excited states at high angular momentum in Barium collisions with Xenon.** Roussel, F.; Breger, P.; Gounand, F.; Spiess, G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). 1988. 2p. (In French). (CONF-8806459–: 21. national colloquium on physics of atom and electron collisions, Caen (France), 21-24 Jun 1988). Order Number DE90756349. Available from NTIS (US Sales Only), PC A02/MF A01.

Published in summary form only. AUTOIONIZATION/rydberg states; AUTOIONIZATION/angular momentum transfer; BARIUM; XENON; ELECTRONIC STRUCTURE; DYE LASERS; AUTOIONIZATION; ATOM-ATOM COLLISIONS

22850 (CONF-8906270–4) **Born expansions for charged particle scattering.** Macek, J.H. (Tennessee Univ., Knoxville, TN (USA)); Barrachina, R.O. Oak Ridge National Lab., TN (USA). [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989. Order Number DE90008491. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

High-order terms in Born expansions of scattering amplitudes in powers of charge are frequently divergent when long-range Coulomb interactions are present asymptotically. Expansions which are free from these logarithmic divergences have been constructed recently. We illustrate these expansions with the simplest example, namely the non-relativistic Rutherford scattering of two charged particles. This approach represents an adequate framework for the calculation of transition amplitudes and a comprehensive starting point for the development of consistent perturbation approximations in multi-channel descriptions of strongly interacting atomic systems. 17 refs.

22851 (INIS-mf–11522) **Atomic hydrogen in a magnetic trap.** Roijen, R. van. Amsterdam Univ. (Netherlands). 29 May 1989. 84p. Order Number DE90706036. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This thesis describes the construction and application of a static magnetic trap for atomic hydrogen. It is demonstrated that densities of up to $3*10^{14}$ cm $-^3$ at temperatures of 80 to 200 mK can be achieved with a technically simple method of filing the trap. Double polarization is shown to occur spontaneously in the trapped gas, and the dipolar relaxation rate and its field dependance are measured confirming theoretical predictions. These results show that atomic hydrogen is a promising material for the achievement of Bose-Einstein condensation provided that apart from the present method of cooling the gas, which is shown to impose a lower limit on the temperature, another cooling mechanism is supplied to reach lower temperatures. The density reached was two orders of magnitude higher than that of trapping experiments done at MIT where the technique of evaporate cooling was used to reach a temperature lower that 3 mK. 138 refs., 27 figs.

22852 (INIS-mf–11547) **Energy distribution in dissociations of polyatomic molecules.** Koernig, S.A. Amsterdam Univ. (Netherlands). 1 Sep 1989. 105p. Order Number DE90706039. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

In this thesis studies are reported of fragmentation processes in polyatomic molecules. In order to find out which dissociation reactions take place, how are brought about by the internal energy of the reactant, and to investigate the structure of the dissociating "transition state", the fragment mass and the corresponding kinetic energy release (KER) are determined by differential translational

spectroscopy using a position and time sensitive two-particle coincidence detector. The results are interpreted using the statistical theory of unimolecular dissociation. It turns out that the standard assumptions of the theory, especially in calculating KER-distributions, are not realistic in all molecules considered. Dissociation is induced by the neutralization with alkali metal vapor. In Ch. 2 the experimental method and the analysis of the data (dissociation pathways, branching ratios and ε-d-distributions) are introduced and exemplified by measurements of cyclohexane, which represents the upper limit in precursor and fragment mass accessible in the apparatus. In Ch. 3 a study is reported of the molecules methylchloride (CH_3Cl) and the acetylradical (CH_3CO). In spite of their similar geometric structures, completely different dissociation mechanisms have been found. Methylchloride dissociates via a repulsive state; acetyl radicals show energy scrambling. The energy distribution from dissociating acetyl exemplifies dynamical effects in the dissociation. In Ch. 4 an investigation of a number of prototype hydrocarbons is presented. The dissociation pathways of several small linear alkanes indicate that neutralization takes place to unknown repulsive potentials, of which the position and steepness are determined from the kinetic energy release. 118 refs., 40 figs., 5 tabs.

22853 (INIS-mf–11548) **Stark effect in Rydberg states of helium and barium.** Lahaije, C.T.W. Vrije Univ., Amsterdam (Netherlands). 18 Jan 1989. 96p. Order Number DE90706040. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This thesis, which deals with the effect of an electric field up to moderate field strengths on atoms with two valence electrons outside closed shells, in casu helium and barium, contains chapter in which the linear Stark effect in the 1 snp ^{1,3}p Rydberg states of helium (n around 40) has been studied in a CW laser-atomic beam experiment. The evolution of the angular momentum manifolds into the n-mixing regime was followed and avoided level crossing were observed. Stark manifolds were also calculated by diagonalization of the complete energy matrix in the presence of an electric field. It turned out to be necessary to include up to five n-values in the calculations already at moderate values of the field to reproduce the data within the experimental accuracy (a few MHz), especially in the regime of the avoided crossings. 147 refs., 30 figs., 8 tabs.

22854 (JAERI-M–89-151) **Low energy ion generator: Performance results and tests irradiation.** Nakase, Yoshiaki (Japan Atomic Energy Research Inst., Neyagawa, Osaka (Japan). Osaka Lab. for Radiation Chemistry). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 75p. (In Japanese). Order Number DE90759905. Available from NTIS (US Sales Only), PC A04/MF A01.

In order to investigate the modification of polymer surface by ion bombardment, low energy ion generator has been constructed. In this report were described system design construction, generator components such as power system and evacuation system, the results of performance test. A maximum beam intensity of Kr^+ was 1.6 mA at 35 kV on a Ti-target. From the preliminary experimental results of Kr^+ irradiation, the coloration (carbonization) of the polymer surface, i.e. the increase of optical density, was observed. The relationship between the optical density change of irradiated polymer film and Kr^+ beam currents as measured by Faraday Cup will provide a convenient method to estimate absorbed ion energy in the film. (author).

22855 (LBL–28126) **Vibrational state-resolved differential cross sections for the D + H_2 → DH + H reaction.** Continetti, R.E. Lawrence Berkeley Lab., CA (USA). Nov 1989. 326p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008388. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

In this thesis, crossed-molecular-beams studies of the reaction D + H_2 → DH + H at collision energies of 0.53 and 1.01 eV are reported. Chapter 1 provides a survey of important experimental and theoretical studies on the dynamics of the hydrogen exchange reaction. Chapter 2 discusses the development of the excimer-laser photolysis D atom beam source that was used in these studies and preliminary experiments on the D + H_2 reaction. In Chapter 3, the differential cross section measurements are presented and compared to recent theoretical predictions. The measured differential cross sections for rotationally excited DH products showed significant deviations from recent quantum scattering calculations, in the first detailed comparison of experimental and theoretical differential cross sections. These results indicate that further work on the H_3 potential energy surface, particularly the bending potential, is in order.

22856 (LBL–28206) **Infrared absorption study of zinc-doped silicon.** Merk, E.; Heyman, J.; Haller, E.E. Lawrence Berkeley Lab., CA (USA). Nov 1989. 7p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00098. Grant DMR-8806766. (CONF-891119–102: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007779. Available from NTIS, PC A02/MF A01 - OSTI.

We report high resolution infrared absorption spectra associated with the deep zinc acceptor in silicon. The optical transitions between ground and bound excited "p-like" states of the neutral helium-like double acceptor Zn^0 center have been observed for the first time. The absorption cross section for the hole transition is found to be very small, of the order of 10^{-17} cm^2. Energy spacings of the $P_{3/2}$ Rydberg series are very similar to the spacings of the group-III acceptors, suggesting that, in spite of the large ground state binding energy, effective mass approximation still applies to the bound excited states. This represents one more case where the strong central cell potential does not significantly disturb the neutral helium-like bound excited states. Similar observations have been made for the less deep neutral double acceptor Be, and for the chalcogens donors S, Se and Te. The optical ionization energy of $Zn^{0/-}$ has been determined to be 2575 cm^{-1} (319 MeV). Two additional sets of absorption lines related to zinc have been observed at 2130 cm^{-1} and 2758 cm^{-1}. Their origin will be discussed. 15 refs., 5 figs., 1 tab.

22857 (PB–90-133158/XAB) **Center for Atomic, Molecular, and Optical Physics technical activities. 1989.** Gebbie, K.B. National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Center for Atomic, Molecular and Optical Physics. Dec 1989. 364p. (NISTIR–89/4184). Available from NTIS, PC A16/MF A02.

See also PB–89-132302.

This report summarizes the research and technical activities of the Center for Atomic, Molecular and Optical Physics (CAMOP) during the Fiscal Year 1989. The activities include work in the areas of fundamental constants, radiation physics, surface science, molecular spectroscopy, electron and optical physics, atomic and plasma spectroscopy, time and frequency, quantum metrology, and quantum physics.

22858 (PNL–6100-Pt.4, pp. 15-17) **Target ionization by proton impact.** DuBois, R.D. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

A fundamental knowledge of the mechanisms by which radiation interacts with matter is essential to understanding dose-response relationships in terms of quantifiable chemical and physical processes. In our attempts to understand proton impact ionization of atomic and molecular targets, total ion (σ^+) and electron (σ^-) production cross sections, cross sections for multiple-target ionization ($\sigma^T q$) without regard to charge transfer and multiple-target ionization cross sections ($\sigma^{ij} q$) for direct ionization (i=j) and for charge transfer (j<i) have been measured. These cross sections have been combined with other information obtained from the literature to provide a total, consistent picture of target ionization resulting from proton impact. One of the aims of this effort is to show the relationship between the experimentally measurable quantities and the initial vacancy production mechanism.

22859 (PNL–6100-Pt.4, pp. 16-17) **Target ionization by helium ion impact.** DuBois, R.D. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Projectiles arriving at the collision region with bound electrons of their own have been tested. Initial investigations have concentrated on He^+ impact in the study of both total ion and electron production and the amount of multiple ionization that occurs. Additional details at lower impact energies have been obtained for the direct ionization and the electron capture channels. It was shown that the predominant electron production mechanism for slow He^+ impact can be the multiple ionization channel; namely, electron capture plus one or more additional target ionizations. This was found to be even more important in the case of He^{2+} impact, where both the single and the double electron capture channels can contribute to the free electron production as effectively as does the direct ionization channel. These measurements were originally made for impact energies lower than 100 keV/atomic mass unit (amu), but in the case of He^+ impact measurements have now been extended to 500 keV/amu. At these higher impact energies, the importance of the electron capture channel is rapidly decreasing; however, the electron loss channels become very important.

22860 (PNL–6100-Pt.4, pp. 19-20) **Structured ion impact: Doubly differential cross sections.** DuBois, R.D. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The electron emission in coincidence with a projectile that has been ionized has been measured, thus making it possible to separate and identify electrons resulting from these various mechanisms. In 1985, coincidence doubly differential cross sections were measured for 400 to 750 keV/atomic mass unit (amu) He^+ impact on He, Ne, Ar, Kr, and H_2O. Cross sections were measured for selected angles and for electron energies ranging from 10 to 1000 eV. Because of the coincidence mode of measurement, the total electron emission was subdivided into its target emission and its projectile emission components. The most interesting findings were that target ionization does not account for the electron emission spectrum at lower electron energies. A sizable percentage of these low-energy electrons were shown to originate as a result of simultaneous projectile/target ionizations. Similar features were observed for all targets and impact energies that were studied.

22861 (PNL–6100-Pt.4, pp. 25-26) **An analytic model for ionization distributions produced in nanometer sites by protons.** Wilson, W.E.; Paretzke, H.G. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The initial spatial pattern of energy deposition by ionizing radiation plays a significant role in the subsequent evolution of biologically active chemical species. The study of track structure includes both theoretical and experimental investigation of the spatial pattern of energy deposition. The modeling of stochastic processes in the transfer of energy in macromolecular systems focused on understanding anisotropic radical yields observed in neutron irradiation of oriented deoxyribonucleic acid (DNA) fibers. Extensive computer simulations of proton tracks have been made for protons of energy E, passing through spherical sites of diameter d, off center by a distance b, which we call eccentricity. Computed ionization distributions for $0.3 < E < 20$ MeV, $2 < d < 1000$ nm, and $0 < b > d/2$ were obtained. The log normal function, $f(j) = EXP(-(\ln(j)-\mu)^2 / 2\sigma^2) / \sigma j (2\pi)$ is used to represent these distributions phenomenologically. A concise computer code system written in FORTRAN is under development to evaluate the model of the stochastics of ionization. For high-velocity charged particles and sufficiently small sites it is quite possible for the particle to pass through the site without depositing any energy or without ionization. This situation indicates a breakdown in the proportionality between fluence and dose, and it is therefore desirable to know how frequently this happens and, ideally, to be able to quantify the frequency. From the computer simulations it was discovered that in sites smaller than 1000 nm in diameter, the frequency for zero ionization is simply related to the cross sections for ionization, $f(j\text{-}O) = EXP[-d(1-b^2)^{\frac{1}{2}}/\lambda_j(E)_p]$ where j is the ionization number and λ_j is the mean free path for the interaction.

22862 (PNL–6100-Pt.4, pp. 28) **Track structure for 10- to 300-keV protons.** Wilson, W.E. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Simulation of ion track structures has been extended down to an ion energy of 10 keV by developing algorithms for the charge-exchange cross sections and the accompanying delta-ray spectra. These results must be considered preliminary, however, because of the approximate nature of some of the code extensions. For the single differential cross section (SDCS) for delta-ray emission, use of a hydrogenic approximation by Professor M.E. Rudd has been made. The Rudd algorithm is for low-energy ion-induced delta-ray emission from hydrogen rather than water. It is used to estimate emission from each valence shell of water vapor by allowing for the different binding energies, and then sum the shells to get a total for the eight valence electrons in the molecule. This procedure produces an ion stopping power that is about 25% too large around 50 to 100 keV, decreasing on each side of this to become 5% to 10% too small at 10 and 300 keV. More interactions occur on the average within a given site size than occur for higher-energy ions; larger mean values produce more symmetric Gaussian-like distributions.

22863 (PNL–6100-Pt.4, pp. 28-29) **Microscopic track structure of equal linear-energy-transfer heavy ions.** Wilson, W.E.; Criswell, T.L. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The spatial distributions of ionization and energy deposition produced by heavy (HZE) ions are crucial to an understanding of their radiation quality as exhibited, for example, in track segment experiments of cell survival and chromosome aberrations of mammalian cells. The stopping power, or linear energy transfer (LET), of a high-velocity ion is proportional to the ratio Z**2/v**2, where Z and v are the atomic number and velocity, respectively, of the moving ion, apart from a slowly varying logarithmic factor. The maximum delta-ray energy that an ion can produce is proportional to v**2 (nonrelativistically). Therefore, two HZE ions having the same LET, but in general different Z and v, will have different maximum delta-ray energies and consequently will produce different spatial patterns of energy deposition along their paths.

22864 (UCID–21792) **Modelling Doppler broadening in Raman propagation.** Sacks, R. Lawrence Livermore National Lab., CA (USA). 28 Feb 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008042. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In December 1986, Karr described an elegant treatment for inhomogeneous broadening of Raman lines, within the context of an integral formulation of the Bloch equation. This formulation relied, for important simplifications, on the assumptions that the molecular population inversion be independent of velocity and that the velocity distribution be Maxwellian. Here we derive an alternative description — a truncated velocity moment series for the differential Liouville equation.

22865 (UCID–21873) **L shell XANES [x-ray absorption near edge structure] for solid metals: Ti, V, Cr, Fe, Ni, Cu.** Del Grande, N.K. Lawrence Livermore National Lab., CA (USA). Jan 1990. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008043. Available from NTIS, PC A02/MF A01 - OSTI.

The L shell x-ray absorption near edge structure (XANES) for the 3d transition metals Ca-Cu is dominated by atomic-like behavior which is poorly understood. It has been studied by electron energy loss spectroscopy (EELS) and bremsstrahlung isochromat spectra (BIS). More and better photoabsorption cross-section measurements are needed over the sparsely studied 400–1500 eV region to test theoretical methodologies which fuse atomic and condensed matter theories. Progress has been made reporting absolute photoabsorption cross sections taken with the spherical grating monochromator on beamline 8-2 at SSRL in 1989.

22866 (UCID–21918) **Tables of average distributions of particles emitted by ionized elements (Z = 6–100).** Lee, P.; Rathkopf, J.; Cullen, D.; Perkins, S. Lawrence Livermore National Lab., CA (USA). Jan 1990. 70p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008144. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Tables giving the average division of energy between electrons and x-rays emitted by singly ionized elements undergoing bound-bound transitions are provided. The expected number of particles is also given. This data is tabulated by atomic number and subshell of initial vacancy. A description of the method of calculation is also presented. 2 refs., 1 fig., 1 tab.

22867 (UCRL–53901) **The time dependent Hartree-Fock calculation of ion-molecule scattering.** Tiszauer, D.H. Lawrence Livermore National Lab., CA (USA). 30 Dec 1988. 180p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008323. Available from NTIS, PC A09/MF A01 - OSTI.

Thesis. Submitted to Univ. of California, Davis.

An alternative semiclassical method of handling reactive molecular collisions that involve charge exchange or electronic transitions is presented. A means of time propagating the electronic wave function and time propagating the classical equations of motion for the nuclei through the collision in a self-consistent fashion is developed by use of the time-dependent Hartree Fock (TDHF) method. This replaces the traditional semiclassical two-step approach which requires a calculation of the electronic potential energy surfaces and then solves for the classical nuclear motion on these surfaces. It is shown that the self-consistent propagation of the electronic wave function and the classical nuclear motion implicity includes the nuclei-electronic coupling that is normally ignored in the Born-Oppenheimer approximation. The coupling included is responsible for nonadiabatic electronic transitions encountered in molecular collisions. The TDHF method is tested on a model collision of H_2+H^+ in the low energy (2 eV) regime. The program used in the computations was adapted from previous nuclear and atomic TDHF calculations, and was implemented on a vector machine. Results of the calculation qualitatively compare to the known results for the H_2+H^+ reactive system showing reaction, electronic transition, and translational to vibrational energy transfer. Developments in computational single-processor speed, the greater availability of vector and array processors, and the simplicity of graphical representation of TDHF results promises to make the molecular TDHF approach a very viable tool for the study of reactive molecular scattering.

22868 In situ x-ray scattering of monolayers adsorbed at electrochemical interfaces. Toney, M.F. (IBM Research Div., Almaden Research Center, San Jose, CA (US)); Melroy, O.R. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Surface x-ray scattering has been used to study in-situ the structure of Pb monolayers electrochemically adsorbed on Ag (111) electrodes. Pb forms an incommensurate, hexagonal two-dimensional (2D) solid, which is rotated approximately 4.5^0 from the substrate symmetry directions and compressed relative to bulk Pb. Between monolayer formation and bulk deposition, the Pb-Pb near neighbor distance decreases linearly with applied potential. Due to the chemical equilibrium between the Pb monolayer and the Pb in solution, the isothermal compressibility of the monolayer can be measured and is in good agreement with that calculated for a 2D non-interacting free electron gas model of the monolayer. It is observed that the intensity of surface diffraction from the Ag substrate (the Ag crystal truncation rod) decreases when the Pb monolayer is adsorbed, although the cause of this is not known.

22869 Bonding in thin epitaxial $CoSi_2$ films on Si(100). Chambliss, D.B. (School of Applied and Engineering Physics, Cornell Univ., Ithaca, NY (US)); Rhodin, T.N.; Rowe, J.E.; Yalisove, S.M. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Epitaxy of $CoSi_2$ layers on Si crystal surfaces can be strongly influenced by growing appropriate template layers. The authors report the electronic structure of thin epitaxial $CoSi_2$ on Si(100) studied with angle-resolved photoemission to investigate atomic bonding in the layers and at their boundaries. Most Co atoms in the layers are in a $CoSi_2$-like environment, including those Co atoms near the free surface. Cobalt atoms at the Si-$CoSi_2$ interface seem to have fewer Si neighbors.

22870 Valence band electronic structure of cleaved iron oxide single crystals studied by resonant photoemission. Lad, R.J. (Applied Physics, Yale Univ., New Haven, CT (US)); Henrich, V.E. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors report synchrotron radiation used to perform resonant photoemission measurements across the 3p–3d photoabsorption threshold from cleaved Fe_xO ($x \simeq 0.945$), Fe_3O_4, and α-Fe_2O_3 single crystal surfaces. The resonant enhancement of the Fe 3d photoelectrons allows the Fe 3d-derived final states in the valence band to be distinguished from the overlapping O 2p states. Using well-characterized single crystals, the distributions of Fe 3d-derived states associated with the ferrous (Fe^{2+}) and ferric (Fe^{3+}) cations have been identified. The Fe 3d-derived states are found to extend about 18 eV below the Fermi level in each oxide, which can be attributed to a significant amount of hybridization between the Fe 3d and O 2p orbitals.

22871 Bond selective chemistry with photon-stimulated desorption. Yarmoff, J.A. (National Institute of Standards and Technology, Surface Science Div., Gaithersburg, MD (US)); Joyce, S.A. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors report on the photon stimulation desorption of fluorine ions from silicon surfaces studied via excitation of the Si 2p core level with synchrotron radiation. These results show that the process is chemically selective in that the removal of a fluorine ion from a silicon species in a given oxidation state can be enhanced by tuning the photon energy to the excitation wavelength corresponding to a transition from the 2p core level of the bonding atom to the conduction band minimum. This process was studied as a possible means for the production of surfaces with selected compositions of species. The results of selective exposure of fluorinated surfaces to monochromatized radiation indicate that secondary desorption processes and the inherent chemistry of the surface reactions can override the effects of selective desorption. Other possibilities for selective surface reactions via core-level excitations are discussed.

22872 The recoil proton polarization in πp elastic scattering. Seftor, C.J. Thesis (Ph. D.). 196p. George Washington Univ., Washington, DC (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-00,504.

The polarization of the recoil proton for π^+p and π^-p elastic scattering has been measured for various angles at 547 MeV/c and 625 MeV/c in a collaborative experiment involving participants from the George Washington University: the University of California, Los Angeles; and Abilene Christian University. The experiment was performed at the P^3 East experimental area of the Los Alamos Meson Physics Facility. Beam intensities varied from 0.4 to 1.0 x 10^7 π^- s/sec and from 3.0 to 10.0 x 10^7 π^+ s/sec. The size of the beam spot at the target was 1 cm in the horizontal direction by 2.5 cm in the vertical direction. A liquid-hydrogen target was used in a flask 5.7 cm in diameter and 10 cm high. The scattered pion and recoil proton were detected in coincidence using the large acceptance spectrometer (LAS) to detect and analyze the momentum of the pions and the JANUS recoil polarimeter to detect and measure the polarization of the protons. Results from this experiment are compared to analyzing power data previously taken by this group and to partial-wave analysis predictions.

22873 Nuclear spectroscopy of neutron-rich odd-A N = 61 isotones in the deformed A ≈ 100 region. Goulden, J.D. Thesis

(Ph. D.). 234p. Univ. of Oklahoma, Norman, OK (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-04,355.

The level structures of ^{99}Sr and ^{101}Zr have been studied through the β-decay of their parents ^{99}Rb and ^{101}Y, which were produced through the thermal neutron fission of ^{235}U at the Isotope Separator On-Line TRISTAN, Brookhaven National Laboratories. In ^{99}Sr, 72 γ rays are placed in a level scheme containing 27 levels, and in ^{101}Zr, 97 γ rays are placed in 37 levels. The rotational structure of both nuclei indicates an axially symmetric deformation in the range $0.20 < \gamma < 0.30$. The ground-state band of each is associated with the 3/2[411] Nilsson single-particle orbital. In ^{99}Sr, eight additional levels below 1200 keV are tentatively associated with rotational bands constructed on the 3/2[541], 5/2[413], and 5/2[532] Nilsson orbitals. In ^{101}Zr, six additional levels may be associated with bands constructed on spin-1/2, 3/2, and 5/2 levels. Similarities and differences in the structure of the two N = 61 isotones are discussed, as are similarities with the nearby odd-proton nuclei ^{99}Y and ^{101}Y.

6404 Fluid Physics

Refer also to citation(s) 21599, 21996, 22273, 22276, 23157, 23254

22874 (PB–90-856121/XAB) **Computational fluid dynamics: Complex flows requiring supercomputers. January 1975-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 83p. Available from NTISPC N01/MF N01.

Supersedes PB–88-867965.

This bibliography contains citations concerning computational fluid dynamics (CFD), a new method in computational science to perform complex flow simulations in three dimensions. Applications include aerodynamic design and analysis for aircraft, rockets and missiles, and automobiles; heat-transfer studies; and combustion processes. Included are references to supercomputers, array processors, and parallel processors where needed for complete, integrated design. Also included are software packages and grid-generation techniques required to apply CFD numerical solutions. Numerical methods for fluid dynamics, not requiring supercomputers, are found in a separate Published Search. (This updated bibliography contains 132 citations, 49 of which are new entries to the previous edition.)

22875 (SAND–89-3040C) **A simple multicomponent fluid theory with accurate physics.** Passman, S.L. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center); Drew, D.A. Sandia National Labs., Albuquerque, NM (USA). 24 Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005108–1: Symposium on structured continua, Sherbrooke (Canada), 22-25 May 1990). Order Number DE90006537. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Generally multicomponent mixtures can exhibit a rich collection of phenomena. Thus it is to be expected that they will be described by complicated theories. In this paper we describe a relatively simple theory that is still theoretically correct, and discuss some of the phenomena that it exhibits. 12 refs.

22876 (UCRL–99707) **Domain decomposition for a boundary-value problem with a shock layer.** Hedstrom, G.W. (Lawrence Livermore National Lab., CA (USA)); Howes, F.A. Lawrence Livermore National Lab., CA (USA). Mar 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8903169–3: 3. Society for Industrial and Applied Mathematics (SIAM) conference on domain decomposition methods, Houston, TX (USA), 20-22 Mar 1989). Order Number DE90007857. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We propose a domain decomposition method for a singularly perturbed elliptic partial differential equation for problems in which the solution has a shock layer interior to the domain. This method is designed for situations in which it is desired to resolve the behavior within the shock layer. 11 refs., 2 figs.

22877 **Vortex lattices in theory and practice.** Campbell, L.J. (New York Univ., NY (USA)). pp. 229 of Mathematical aspects of vortex dynamics; Proceedings of the Workshop, Leesburg, VA, Apr. 25-27, 1988. Caflisch, R.E. Society for Industrial and Applied Mathematics, Philadelphia, PA (US) (1989). (CONF-8804320–: Workshop on mathematical aspects of vortex dynamics, Leesburg, VA (USA), 25-27 Apr 1988).

Infinite, twofold periodic vortex arrays are studied. An expression for the energy density of an arbitrary vortex lattice is discussed. For the case of two vortices per unit cell, the morphology of stable lattices can be described completely. A nontrivial physical realization of such lattices is a rotating mixture of He-3 and He-4 at temperatures so low that both isotopic components are superfluid. The structure of the expected lattices is quite different from the usual triangular structure. Magnetic flux lines in high-temperature superconductors show a one-parameter family of degenerate ground states of lattice due to the anisotropy of the vortex-vortex interaction. The case of vortices confined to a grid is also discussed. 11 refs.

22878 **Development of a numerical method for full solution of magnetohydrodynamic flows and application to fusion blankets.** Kim, C.N. Thesis (Ph. D.). 146p. Univ. of California, Los Angeles, CA (US) (1989). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-09,408.

A numerical algorithm was developed to predict the characteristics of the flow field in liquid-metal magnetohydrodynamic (MHD) flow with a relatively large Hartmann number and interaction parameter. Using this algorithm, steady-state, incompressible, viscous, 3-dimensional MHD flow under various flow conditions was investigated at an extremely low magnetic Reynolds number by means of the finite-volume method. A differential form of a Poisson-type pressure equation is used to incorporate the effect of magnetic force on the pressure field in liquid-metal MHD flow. The primary variables are solved in a split manner as a predictor step, and these variables are then corrected as a corrector step to satisfy the global and local conservations. The use of the control-volume approach enables the implementation of a corrector step, which contributes to convergence and physical accuracy. The basic algorithm and the numerical scheme developed were successful in solving 3-dimensional problems at a relatively large interaction parameter, which is of considerable interest in fusion-reactor applications. Numerical results for liquid metal MHD flows under different flow conditions are presented.

6450 High Energy Physics

Refer also to citation(s) 23216

22879 (DOE/ER/40366–2) **[Research in high energy physics]: Annual report, 1988–1989.** LoSecco, J. Notre Dame Univ., IN (USA). Dept. of Physics. [1989]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-87ER40366. Order Number DE90007751. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We review the efforts of the Notre Dame non accelerator high energy physics group. Our major effort has been directed toward the IMB deep underground detector. Since the departure of the Michigan group our responsibilities to the group have grown. We are also very active in pursuing physics with the IMB 3 detector. Currently we are studying proton decay, point neutrino sources and neutrino oscillations with the contained event sample.

22880 (LBL–91-Rev.-9/89) **Current experiments in elementary particle physics.** Wohl, C.G. (Lawrence Berkeley Lab., CA (USA)); Armstrong, F.E.; Trippe, T.G.; Yost, G.P.; Oyanagi, Y.; Dodder, D.C.; Ryabov, Yu.G.; Slabospitsky, S.R.; Frosch, R.; Olin, A. Lawrence Berkeley Lab., CA (USA). Sep 1989. 179p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00098. Order Number DE90008062. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

This report contains summaries of 736 current and recent experiments in elementary particle physics (experiments that finished taking data before 1982 are excluded). Included are experiments at

Brookhaven, CERN, CESR, DESY, Fermilab, Tokyo Institute of Nuclear Studies, Moscow Institute of Theoretical and Experimental Physics, Joint Institute for Nuclear Research (Dubna), KEK, LAMPF, Novosibirsk, PSI/SIN, Saclay, Serpukhov, SLAC, and TRIUMF, and also several underground experiments. Also given are instructions for searching online the computer database (maintained under the SLAC/SPIRES system) that contains the summaries. Properties of the fixed-target beams at most of the laboratories are summarized.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 22872

22881 (CEA-CONF–9797) **Electro and photoproduction of strangeness.** Bertini, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Moyenne Energie. 1988. 31p. (CONF-8806236–: 1. European workshop on hadronic physics in the 1990's with multi-GeV electrons, Seillac (France), 27 Jun - 1 jul 1988). Order Number DE90756436. Available from NTIS (US Sales Only), PC A03/MF A01.

Strangeness-production studies and the characteristics of the electron accelerators applied in the experiments are discussed. The strangeness of the nucleon, the polarization in hyperon production, strange dybaryons, hypernuclei and baryons resonance and strangeness are the main topics. The importance of the electromagnetic probe as a tool in hyperon polarization measurements, in order to understand why hyperons become polarized at large momentum transfer, is underlined. High beam energies (30 GeV or so) and targets are needed for the study of the nucleon spin functions, as well as transverse and longitudinal polarization of the beam must be provided. In the following studies the needed energy range has been determinated: for the study of the strangeness content of the nucleon a beam energy higher than 3-4 GeV, in the search of H and D baryons, energies higher than 4 GeV, for the production of hypernuclei, the hyperon polarization and the baryon resonances study, beam energies ranging in the 3-4 GeV gap are enough. The relation meson-nucleon sigma terms to the strange quark content of the nucleon is discussed. In the measurement of the K-N sigma term, low energy Kaon beams and, possibly, polarized targets are needed.

22882 (DOE/ER/40368–3) **Studies of high energy phenomena using muons: Progress report.** Hedin, D.; Kaplan, D.; Green, J. Northern Illinois Univ., Dekalb, IL (USA). 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-87ER40368. Order Number DE90008272. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report covers the activities of the NIU high energy physics group as supported by DOE contact AC02-87ER40368 during the period from March of 1989 to February of 1990. Our group has two primary efforts. The first is the D0 experiment at the Fermilab proton-antiproton collider, with major emphasis on its muon system. The second is the involvement of a precision study of the A-dependence of massive muon-pion production and a study of low-multiplicity decay modes of charm. We are also participating in the design of detectors for the SSC. Finally, a minor effort is being given to analyzing data from Fermilab of particles with lifetime between 10^{-12} and 10^{-13} seconds. A more detailed description of the work of the NIU high energy physics group can be found in the narrative accompanying our grant renewal proposal. 10 refs.

22883 (FNAL/C–90/39) **High luminosity muon scattering at FNAL.** Bazizi, K. (California Univ., Riverside, CA (USA)); Conrad, J.; Fang, G.; Erdmann, M.; Geesaman, D.; Jackson, H.; Guyot, C.; Virchaux, M.; Holmgren, H.; Malensek, A. Fermi National Accelerator Lab., Batavia, IL (USA). Feb 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890872–6: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90008779. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The charge of this group was to evaluate the physics that can be done with a high luminosity μ scattering experiment at FNAL using the upgraded Tevatron muon beam, and consider the apparatus required. In this report, the physics that can be accomplished with a high luminosity μ scattering experiment is evaluated. The CERN and FNAL μ beams are compared in the context of such an experiment. The expected muon flux with the upgraded machine is estimated. Two possible detectors are compared: the air-core toroid experiment proposed by Guyot et al., and an upgraded version of the E665 double-diode apparatus now in place at FNAL. The relative costs of the detectors are considered. A list of detailed questions that need to be answered regarding the double-diode experiment has be compiled. 2 refs., 10 figs., 2 tabs.

22884 (IPNO-T–89-07) **J/ψ production and the di-muons in oxygen-copper collisions at 200 GeV/nucleon.** Sinquin, A. Paris-11 Univ., 91 - Orsay (France). Jul 1988. 98p. (In French). Order Number DE90756357. Available from NTIS (US Sales Only), PC A05/MF A01.

The oxygen on copper collisions are studied. The aim of the study is the analysis of the J-ψ production at lower energy densities. No discontinuity is observed in the decrease of the ratio R. The R value is the same than for oxygen-uranium collisions, provided the energy density is the same. This effect is not explained, up to now, by classical models (J/ψ absorption in the nucleus it self or in the pion cloud produced in the collision). Ultrarelativistic oxygen beams at 200 GeV/N and very high intensity are applied to provide high energy densities. In these conditions a phase transition from a hadronic phase, to a plasma of deconfined quarks and gluons, can be obtained. For oxygen-uranium collisions, a decrease of the ratio R of the number of J/ψ to the number of continuum dimuons with transverse energy, is observed. These results are in agreement with the predictions of the quarks and gluons plasma models.

22885 (Juel–2296) **Measurement of double differential production cross sections for charged particles for the validation of theoretical models used to describe interactions of high energy protons with matter.** Koch, K.M. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.). Aug 1989. 122p. (In German). Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek. Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek.

Following the increasing interest in reaction data for the medium energy region, the production of light charged particles (A<10) induced by 800 MeV protons was measured at the Los Alamos National Laboratory. The particles were generated on ultra-thin Pb-, Cu-, Al- and C-targets and viewed under 38deg C by a 12,3 m long vacuum time-of-flight telescope employing a detector sandwich consisting of four silicon-surface-barrier detectors and one plastic Pilont B scintillator. A E-, ΔE- and time-of-flight based analysis algorithm made it possible to separate protons (2-65 MeV), deuterons (3-100 MeV), tritons (5-120 MeV), He-3 particles (5-220 MeV), He-4 particles (5-220 MeV) and particles with masses 6, 7, 8 and 9 (4-30 MeV) with an energy resolution better than 2.5% The data were reduced to double differential production cross sections with special considerations on target self absorptions, scattering effects and background corrections. The overall accuracy of the measurement is primary due to counting statistics, absolute proton intensity estimation and target thickness variations from 18 to 29%. The results are in good agreement with other experimental data and were compared with calculations, done by the KFA-HERMES code system using the intranuclear cascade- and evaporation model. (orig.).

22886 (KURRI-TR–318, pp. 26-29) **Detection of π^0 meson with Pb-glass Cherenkov counters.** Shinohara, A. (Nagoya Univ. (Japan). Faculty of Science); Imanishi, N.; Yoshimura, Y. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. PIONS NEUTRAL/cherenkov counters; CHERENKOV COUNTERS/pions neutral; PIONIC ATOMS; HYDROGEN 1; CHARGE EXCHANGE; GAMMA DETECTION; GLASS; LEAD; SENSITIVITY; EXPERIMENTAL DATA

22887 (LAL–88-11) **Measurement of the reaction $e^+e^- \rightarrow \eta \pi^+ \pi^-$ in the center of mass energy interval 1350-2400 MeV.** DM2 Collaboration. DM2 Collaboration. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. May 1988. 15p. Order Number DE90756406. Available from NTIS (US Sales Only), PC A03/MF A01.

The $e^+e^- \rightarrow \eta \pi^+ \pi^-$ reaction has been measured in the center of mass energy interval 1350-2400 MeV by the magnetic detector DM2 at the Orsay storage ring DCI. Under the hypothesis of only one large resonance the cross section is not fit in a satisfactory way. The branching ratio $\tau^- \rightarrow \eta \pi^- \pi^0 \nu_\tau = (0.13 \pm 0.02)\%$ is deduced via CVC from the above measurement.

22888 (LAL–88-12) **First observation of three pseudoscalar states in the $J/\Psi \rightarrow \gamma \rho \rho$ decay.** DM2 Collaboration. DM2 Collaboration. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. Jun 1988. 25p. Order Number DE90756407. Available from NTIS (US Sales Only), PC A03/MF A01.

The $J/\Psi \rightarrow \gamma \pi^+ \pi^- \pi^+ \pi^-$ and $J/\Psi \rightarrow \gamma \pi^+ \pi^- \pi^0 \pi^0$ decays have been studied by the DM2 experiment from 8.6 million J/Ψ. Both decays exhibit a large pseudoscalar $\rho \rho$ dynamics. Three $J^{PC} = 0^{-+}$ resonant states (more than 3500 events, globally) decaying into $\rho^0 \rho^0$ and with less statistical significance into $\rho^+ \rho^-$ are observed. Their branching ratios into $\rho^0 \rho^0$ and $\rho^+ \rho^-$ support an $I^G = 0^+$ assignment. These states, named η (1500), η (1800) and η (2100), are not associated with well established resonances and do not fit in the standard q antiq scheme.

22889 (LAL–88-13) **Looking at CP invariance and quantum mechanics in $J/\Psi \rightarrow \Lambda\text{anti}\Lambda$ decay.** DM2 Collaboration. DM2 Collaboration. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. May 1988. 14p. Order Number DE90756455. Available from NTIS (US Sales Only), PC A03/MF A01.

The $J/\Psi \rightarrow \Lambda\text{anti}\Lambda \rightarrow p\pi^-\text{antip}\pi^+$ decay is used to test the CP invariance in the Λ hyperon decays by measuring $A = (\alpha_\Lambda + \alpha_{\text{anti}\Lambda})/(\alpha_\Lambda - \alpha_{\text{anti}\Lambda})$ where α_Λ ($\alpha_{\text{anti}\Lambda}$) is the decay asymmetry parameter of the Λ(antiΛ). The obtained value $A = 0.01 \pm 0.10$ is in agreement with CP invariance. The used formalism would permit to check Quantum Mechanics, assuming CP invariance.

22890 (LAL–88-47) **The pion electromagnetic form factor in the time-like energy range $1.35 \leq \sqrt{s} \leq 2.4$ GeV.** DM2 Collaboration. DM2 Collaboration. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. Oct 1988. 15p. Order Number DE90756415. Available from NTIS (US Sales Only), PC A03/MF A01.

The $e^+e^- \rightarrow \pi^+\pi^-$ cross section has been measured from about 280 events (an order of magnitude more than the previous world statistics) in the energy interval $1.35 \leq \sqrt{s} \leq 2.4$ GeV with the DM2 detector at DCI. The pion squared form factor shows a deep minimum around 1.6 GeV/c^2 and is best fit under the hypothesis of two ρ like resonances $\simeq$ 0.2 GeV/c^2 wide with 1.43 and 1.76 GeV/c^2 masses.

22891 (LAL–88-61) **An experimental study of e^+e^- annihilation into four leptons at $\sqrt{S} \geq 35$ GeV.** CELLO Collaboration. CELLO Collaboration. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. Dec 1988. 21p. (DESY–88-192). Order Number DE90756443. Available from NTIS (US Sales Only), PC A03/MF A01.

The three reactions $e^+e^- \rightarrow e^+e^-e^+e^-$, $e^+e^- \rightarrow e^+e^- \mu^+\mu^-$ and $e^+e^- \rightarrow \mu^+ \mu^- \mu^+ \mu^-$ have been studied using the CELLO detector at PETRA. The data correspond to 130 pb^{-1} collected at energies ranging from 35 GeV to 46.8 GeV. A detailed analysis of the distribution of the observed events in phase space shows good agreement with QED to order α^4.

22892 (LBL–28112) **Recent results on jet physics and tests of QCD [Quantum Chromodynamics] in e^+e^- annihilation.** Bethke, S. Lawrence Berkeley Lab., CA (USA). Nov 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8906294–1: Workshop on the standard model at present and future accelerator energies, Budapest (Hungary), 27 Jun - 21 jul 1989). Order Number DE90007757. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Experimental investigations to test specific predictions of Quantum Chromodynamics and to adjust the free parameters of the theory are reviewed. Determinations of the strong coupling constant, α_s, in Υ-decays and in the continuum of e^+e^- annihilations are summarized and discussed. Studies on production rates of multijet hadronic final states in the center of mass energy range of 22 GeV to 93 GeV, including optimizations of both the scale parameter $\Lambda_{\overline{MS}}$ and the renormalization scale μ^2 in $O(\alpha_s^2)$ perturbative QCD, are presented. The status of experimental tests of the nonabelian nature of QCD is summarized. 48 refs., 9 figs., 4 tabs.

22893 (LBL–28196) **Measurements of e^+e^- pair production at the Bevalac.** Carroll, J. (California Univ., Los Angeles, CA (USA). Dept. of Physics). Lawrence Berkeley Lab., CA (USA). Feb 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098;AS03-81ER40027. (CONF-8902107–1: School on nuclear matter and heavy ion collisions, Les Houches (France), 7-16 Feb 1989). Order Number DE90008495. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A complete kinematic description of a lepton pair requires 6 independent variables, in contrast to the case of a real photon, where there are only 3 independent variables. The mass and momentum of the virtual photon may be specified independently, with the remaining variables being the two angles specifying its production direction, and the two angles of the decay in its rest frame. It has become customary to use as kinetics variables: the mass, M; the transverse momentum, P_t; and a longitudinal variable, either the rapidity – Y, or the scaling variable – X. Data are almost always presented as a function of only one of these variables. This may be due to the difficulty inherent in presenting multidimensional data, to poor statistics, to limited experimental acceptance, or to some combination of these reasons. It should be noted, however, that these one-dimensional projections always represent integrations over the remaining variables – integrations within which the shape and limits of the acceptance of the experimental apparatus must be taken into account. The effects of the acceptance must be understood in comparing experimental data either to theory or to results from experiments with different coverage of the total phase space. Although we have a strong interest in studying nucleus-nucleus collisions using the tool, most of the discussion presented here will be about our measurements in p+Be collisions. It was necessary for us to make these measurements because, in the relevant range of incident energies, the yield of electron pairs from nucleon-nucleon collisions had not been measured, nor was the hadronic production mechanism understood. A brief discussion of lepton production in hadronic collision will help put out our results in a proper framework. 15 refs., 9 figs., 2 tabs.

22894 (LPNHEP–88-11) **Neutrino oscillations at accelerators.** Bernardi, G. Paris-6 Univ., 75 (France). Lab. de Physique Nucleaire et de Hautes Energies. 1988. 7p. (CONF-880867–: 24. international Rochester conference on high energy physics, Munich (Germany, F.R.), 4-10 Aug 1988). Order Number DE90756362. Available from NTIS (US Sales Only), PC A02/MF A01.

The neutrino oscillation experiments at accelerators are reviewed. Special attention is given to the neutrino mass measurement. The experimental results show that, at present, there is no indication for neutrino oscillations. Neutrino experiments which improve the $\nu_e/\nu.\mu$ knowledge, and which increase the number of neutrino interactions, are needed. With technical developments and the improvement of the limits, the neutrino oscillation discovery can be expected.

22895 (RAL–89-106) **A compilation of data on single prompt photon production in hadron -hadron interactions.** Aurenche, P. (Durham Univ. (UK). Dept. of Physics); Whalley, M.R. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 56p. (DPDG–89/04). Order Number DE90619111. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A compilation of all the available data on Single Prompt Photon Production in Hadron-Hadron Interactions is presented, in both tabular and graphical form. Methods of interpreting these data in terms of a test of quantum chromodynamics (QCD) is also presented to indicate to the reader the scope and general status of the data. All the data in this review can be found in and retrieved from the Durham-RAL HEP Databases (HEPDATA on the RAL and CERN VM systems) together with data on a wide variety of other reactions. (author).

22896 (UCRL–98805) **Experimental search for free quarks in matter.** Hendricks, C.D.; Hornady, R.S. Lawrence Livermore National Lab., CA (USA). May 1988. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8810483–1: International conference on modern electrostatics, Beijing (China), 21-25 Oct 1988). Order Number DE90008359. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An apparatus has been constructed for the measurement of very small electric charges on macroscopic particles with a charge resolution better than 0.05e. Together with the charge measurement system, a generator of small liquid particles has been assembled and used to test the system. To achieve the charge resolution desired, some of the problems which were solved included particle interactions resulting from induced dipoles, particle position and timing measurements to accuracies of a few microns and nanoseconds, operation in high vacuum to avoid aerodynamic effects, and spurious charging of the particles by external effects. The technique, which depends on simple, straight-forward deflection of particles in an electric field, is described and some particle charge measurements are presented.

22897 (UIUC-HEPG–89-18) **Review of charm decay results.** Gladding, G. Illinois Univ., Urbana, IL (USA). [1989]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (CONF-8906204–7: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989). Order Number DE90007811. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper I review recent experimental results on the decays of the charmed mesons, D^0, D^+, and D_s. 27 refs., 7 figs., 3 tabs.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 22762, 22818, 22892

22898 (CONF-8906270–3) **Calculating coherent pair production with Monte Carlo methods.** Bottcher, C.; Strayer, M.R. Oak Ridge National Lab., TN (USA). [1989]. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989. Order Number DE90008404. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We discuss calculations of the coherent electromagnetic pair production in ultra-relativistic hadron collisions. This type of production, in lowest order, is obtained from three diagrams which contain two virtual photons. We discuss simple Monte Carlo methods for evaluating these classes of diagrams without recourse to involved algebraic reduction schemes. 19 refs., 11 figs.

22899 (DOE/ER/40173–5) **Studies in theorectical high energy particles physics: Technical progress report, February 1989–February 1990.** Aratyn, H.; Keung, Wai-Yee; Panigrahi, P.; Sukhatme, U. Illinois Univ., Chicago, IL (USA). Dept. of Physics. Feb 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER40173. Order Number DE90007752. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the research being done at the University of Illinois in theoretical high energy physics. Some areas discussed are string models, collider physics, symmetries in gauge theories, sigma model, radiative decay of mesons, supersymmetry, superconducting, and hydroproduction of charm. (LSP)

22900 (DOE/ER/40215–T10) **On the uniqueness of the radiation amplitude zero in radiative W decay.** Samuel, M.A. (Concordia Univ., Sir George Williams Campus, Montreal, PQ (Canada). Dept. of Physics); Frank, M.; Hamzaoui, C.; Pouliot, D.; Samuel, K.B.; Li, Guowen. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Physics. Oct 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER40215. Order Number DE90007671. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

It is well known that a radiation amplitude zero (RAZ) occurs in radiative W decay ($W^- \rightarrow d\bar{u}\gamma$ or $W^- \rightarrow e\bar{\nu}\gamma$). This RAZ can be used to measure the magnetic moment of the W boson to see if it has the gauge-theory value $\kappa = 1$, and, in this way, test the Standard Model (SM). In this paper we prove that the RAZ in this process is unique and, thus, the experimental discovery of any zero in this process implies that there exists a RAZ and, hence, $\kappa = 1$. 5 refs.

22901 (FNAL/C–89/265-T) **Critique of practical methods for computer evaluation of the hadron spectrum.** Mackenzie, P.B. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8909249–11: Lattice '89 international workshop, Capri (Italy), 18-21 Sep 1989). Order Number DE90008778. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

I review Monte Carlo algorithms for lattice QCD including the dynamical effects of quarks, emphasizing scaling behavior of the algorithms with lattice spacing, volume, and quark mass. 59 refs., 6 figs., 2 tabs.

22902 (LYCEN–88-18) **Wigner-Kirkwood expansion of the quasi-elastic nuclear responses and application to spin-isospin responses.** Chanfray, G. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire). Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire. 1988. 8p. (CONF-880386–: International conference on spin-observables of nuclear probes, Telluride, CO (USA), 14-18 Mar 1988). Order Number DE90756361. Available from NTIS (US Sales Only), PC A02/MF A01.

We derive a semi-classical Wigner-Kirkwood expansion (Planck constant expansion) of the linear response functions. We find that the semi-classical results compare very well to the quantum mechanical calculations. We apply our formalism to the spin-isospin responses and show that surface-peaked Planck constant^2 corrections considerably decrease the ratio longitudinal/transverse as obtained through the Los Alamos (longitudinal momentum) experiment.

22903 (UIUC-HEPG–89-17) **D^0–$\bar{D}^0$ mixing and CP violation: Experimental projections for a τ-charm factory.** Gladding, G. Illinois Univ., Urbana, IL (USA). Aug 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (CONF-8905144–15: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). Order Number DE90007810. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report presents the results of a set of feasibility studies for observing D^0–$\bar{D}^0$ mixing and CP violation in the proposed high luminosity τ-charm factory. These studies are not yet complete, but clear general conclusions can already be drawn. In particular, a year of running with 10^{33} luminosity would allow observation of D^0–$\bar{D}^0$ mixing at the level of 10^{-4} to 10^{-5}, consistent with standard model expectations, while CP violation in the D system could be probed at the 10^{-2} level. 7 refs., 3 figs., 4 tabs.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 22955

22904 (FRNC-R–303) **Introduction to strings and superstrings.** Rausch de Traubenberg, M. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires; Strasbourg-1 Univ., 67 (France). 1988. 97p. (In French). Order Number DE90756359. Available from NTIS (US Sales Only), PC A05/MF A01.

The string theory is applied in the construction of a theory which allows the coupling of the four fundamental interactions and matter. The original model of the string theory describes the hadronic phenomenon of duality. The model extension, which describes the

closed strings and those with a spin, is studied. The supersymmetry and the supersymmetric partner concepts are considered, in order to obtain a superstrings theory. The supersymmetry allows the formulation of a "supertheory", including matter, fields and gravitation. In order to explain the mass of the observable particles, the mechanism of symmetry breaking must be taken into account. The scalar state concept, originated from the supersymmetry breaking, is analyzed. This "supertheory" is not entirely accepted by the scientific world.

6454 Field Theory

22905 (CEA-CONF–9778) **Two-dimensional fractal geometry, critical phenomena and conformal invariance.** Duplantier, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 48p. (CONF-8805355–: Cargese School on common trends in statistical physics and field theory, Cargese (France), 24 May - 4 jun 1988). Order Number DE90756348. Available from NTIS (US Sales Only), PC A03/MF A01.

The universal properties of critical geometrical systems in two-dimensions (2D) like the O (n) and Potts models, are described in the framework of Coulomb gas methods and conformal invariance. The conformal spectrum of geometrical critical systems obtained is made of a discrete infinite series of scaling dimensions. Specific applications involve the fractal properties of self-avoiding walks, percolation clusters, and also some non trivial critical exponents or fractal dimensions associated with subsets of the planar Brownian motion. The statistical mechanics of the same critical models on a random 2D lattice (namely in presence of a critically-fluctuating metric, in the so-called 2D quantum gravity) is also addressed, and the above critical geometrical systems are shown to be exactly solvable in this case. The new "gravitational" conformal spectrum so derived is found to satisfy the recent Knizhnik, Polyakov and Zamolodchikov quadratic relation which links it to the standard conformal spectrum in the plane.

22906 (CEA-CONF–9795) **From the harmonic oscillator to the A-D-E classification of conformal models.** Itzykson, C. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 40p. (CONF-8810482–: Meeting on Integrable models in quantum field theory and statistical Mechanics, Kyoto (Japan), 17-28 Oct 1988). Order Number DE90756416. Available from NTIS (US Sales Only), PC A03/MF A01.

Arithmetical aspects of the solution of systems involving dimensional statistical models and conformal field theory. From this perspective, the analysis of the harmonic oscillator, the free particle in a box, the rational billards is effectuated. Moreover, the description of the classification of minimal conformal models and Weiss-Lumino-Witten models, based on the simplest affine algebra is also given. Attempts to interpret and justify the appearance of A-D-E classification of algebra in W-Z-W model are made. Extensions of W-Z-W model, based on SU(N) level one, and the ways to deal with rank two Lie groups, using the arithmetics of quadratic intergers, are described.

22907 (CEA-CONF–9805) **Level one Kac-Moody characters and modular invariance.** Itzykson, C. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 16p. (CONF-8803253–:). Order Number DE90756437. Available from NTIS (US Sales Only), PC A03/MF A01.

The analysis of SU(N) models, limited to the level one representations of its (untwisted) Kac-Moody or affine algebra, is reported. A discussion to characterize the content of a conformal invariant model is outlined, taking into account the existence of an automorphism of the Lie algebra (a specific property of SU(N), $N \geq 3$). The roots and conformal weights of SU(N) are obtained. It is shown that the obtained automorphism leave (restricted) affine characters invariant and is reflected in an automorphism of the Carton matrix (as well as its representative Dynkin diagramme), and of the root and weight lattices. The transformation under S from the explicit Kac-Weyl formula is considered in the discussion of Weiss-Lumino-Witten model. The validity of S and T formulas, of the level one $A_{N-1}^{(1)}$, to generate a representation of the modular group is proven.

22908 (CEA-CONF–9813) **Lattice models and conformal field theories.** Saleur, H. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 22p. (CONF-8805355–:). Order Number DE90756435. Available from NTIS (US Sales Only), PC A03/MF A01.

Theoretical studies concerning the connection between critical physical systems and the conformal theories are reviewed. The conformal theory associated to a critical (integrable) lattice model is derived. The obtention of the central charge, critical exponents and torus partition function, using renormalization group arguments, is shown. The quantum group structure, in the integrable lattice models, and the theory of Visaro algebra representations are discussed. The relations between off-critical integrable models and conformal theories, in finite geometries, are studied.

22909 (DOE/ER/40272–94) **Superstring field theory.** Preitschopf, C.R. (Florida Univ., Gainesville, FL (USA). Dept. of Physics); Thorn, C.B.; Yost, S.A. Florida Univ., Gainesville, FL (USA). Inst. for Fundamental Theory. [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER40272. (UFIFT-HEP–90-3;CONF-8911164–2: 1989 superstrings workshop, Tuscaloosa, AL (USA), 8-11 Nov 1989). Order Number DE90007694. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We describe the construction of a class of cubic gauge-invariant actions for superstring field theory, and the gauge-fixing of one representative. Fermion string fields are taken in the $-\frac{1}{2}$-picture and boson string fields in the 0-picture, which makes a picture-changing insertion carrying picture number -2 necessary. The construction of all such operators is outlined. We discuss the gauge $b_1 + b_{-1} = 0$, in which the action formally linearizes. Nontrivial scattering amplitudes are obtained by approaching this gauge as a limit. 20 refs.

22910 (IPNO-TH–88-34) **BRST construction of interacting gauge theories of higher spin fields.** Cappiello, L.; Knecht, M.; Ouvry, S.; Stern, J. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Jun 1988. 40p. Order Number DE90756353. Available from NTIS (US Sales Only), PC A03/MF A01.

The problem of constructing consistent interacting theories of an infinite tower of high-spin fields is formulated in terms of a field $\phi(X)$ defined on a finite or infinite-dimensional extended space-time manifold M, generalizing the concept of a string-field ϕ—$x(\sigma)$—. Using the techiques of BRST-cohomology we first analyze the conditions under which a system of compatible wave-equations for ϕ defines a gauge invariant free theory without ghosts in its physical sector. The necessary and sufficient conditions for the existence of a gauge-invariant cubic interaction are then shown to take the concise form of a graded Lie algebra, on which the BRST charge acts as an exterior derivative. Witten's string-field-theory is a particular realization of this algebra. The importance of a search for other realizations, possibly operating on a finite dimensional manifold M and/or leading to an interacting theory of massless gauge fields of any spin, is stressed and commented.

22911 (NIKHEF-H–89-17) **New algorithms for one-loop integrals.** Oldenborgh, G.J. van (Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H); Vermaseren, J.A.M. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H. 6 Oct 1989. 29p. Order Number DE90618365. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

New algorithms are presented for evaluating the scalar one loop integrals for three- and four-point functions for arbitrary masses and external momenta. These formulations are useful both for analytic integration and for numerical evaluation in a computer program. The expressions are very compact and provide for an easy isolation of asymptotic behaviour and potential numerical problems. The tensor integrals have also been rewritten according to new algorithms, making it very easy to express amplitudes in terms of scalar-loop integrals. (author). 2 figs.; 133 schems.

22912 (RAL–89-096) **The space of string configurations in string field theory.** Bordes, J.; Lizzi, F. Rutherford Appleton Lab.,

Chilton (UK). Aug 1989. 10p. Order Number DE90618366. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this paper we consider the set of maps from the interval $(0,\pi)$ which constitute the argument of the functionals of a String Field Theory. We show that in order to correctly reproduce results of the dual model one has to include all square integrable functions in the functional integral, or Ω_0 in terms of Sobolev spaces. (author).

22913 (RRK–89-29) **Affine Toda field theory and exact S-matrices.** Braden, H.W. (Durham Univ. (UK). Dept. of Mathematical Sciences); Corrigan, E.; Dorey, P.E.; Sasaki, R. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Oct 1989. 57p. Order Number DE90759876. Available from NTIS (US Sales Only), PC A04/MF A01.

The masses and three-point couplings for all affine Toda theories are calculated. The exact factorisable S-matrices are conjectured on the basis of the classical masses and couplings and found, in the case of theories based on simply-laced algebras, to give consistent solutions to the bootstrap. An investigation of the properties of the exact S-matrices in perturbation theory is begun but non-perturbative methods will be required to understand the conjectured duality between weak and strong coupling which appears to be a striking feature of these theories. (author).

65 PHYSICS II

6510 Nuclear Physics

22914 (CONF-8909247–6) **Alpha-particles as probes of nuclear shape in the rare earths and structure effects on proton emission in the mass 80 region.** Sarantites, D.G. (Washington Univ., St. Louis, MO (USA). Dept. of Internal Medicine); Nicolis, N.G.; Abenante, V.; Majka, Z.; Semkow; Baktash, C.; Beene, J.R.; Garcia-Bermudez, G.; Halbert, M.L.; Hensley, D.C. Oak Ridge National Lab., TN (USA). [1989]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400;FG02-88ER40406. From ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989. Order Number DE90007886. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Low emission barriers and large subbarrier anisotropies in the alpha-particle decay with respect to the spin direction, of Sn and rare earth compound nuclei, are examined in the light of recent calculations incorporating deformation. For the rare earth systems deformation which increases with spin is necessary to explain the data. Energy spectra and angular correlations of evaporated protons from the $^{52}Cr(^{34}S, 2p2n)^{82}Sr$ reaction were measured in coincidence with discrete transition. Large changes in the shape of the proton spectra were observed when high spin states in different rotation al bands are populated. These effects cannot be explained by phase space arguments in the deexcitation process. They are interpreted as due to near-yrast to near-yrast stretched proton emission, which preferentially populates the yrast band by subbarrier protons. 20 refs., 8 figs.

22915 (DOE/ER/40437–2) **Calorimeter measurements in relativistic heavy-ion research: Progress in research.** Wolf, K.L. Texas A and M Univ., College Station, TX (USA). Research Foundation. Nov 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40437. Order Number DE90007672. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses progress in the following areas: relativistic heavy-ion research; RHIC detector development; and cold fusion.

22916 (IPNO-TH–87-90) **Nuclear photoreactions at intermediate energies.** Christillin, P. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Feb 1989. 111p. Order Number DE90756438. Available from NTIS (US Sales Only), PC A06/MF A01.

We review the interaction of real photons with nuclei up to the GeV region. The common microscopic description of exchange effects below threshold and of the corresponding real photoproduction above, is emphasized. The theoretical problems connected with π photoproduction in Δ region and vector meson photoproduction are spelled out and solved. The gross features of the reaction mechanism are shown to explain both the low energy region, the bulk properties around the Δ resonance as well as the appearance of shadowing only above ρ threshold.

22917 (ISN–8820) **The effective moment of inertia in ^{124}Xe, ^{126}Ba, ^{128}Ba, ^{129}Ce, ^{131}Ce and ^{162}Er isotopes.** Jerrestam, D. (Stockholm Univ. (SE). Inst. of Physics); Elfstrom, S.; Klamra, W.; Lindblad, T.; Linden, C.G.; Barci, V.; El-Samman, H.; Gizon, J. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. Mar 1988. 56p. Order Number DE90756408. Available from NTIS (US Sales Only), PC A04/MF A01.

The γ rays produced in the reactions of 118 MeV ^{12}C on ^{120}Sn, ^{122}Sn, ^{124}Te and 39.5 MeV ^{4}He on ^{161}Dy are investigated by using a sum spectrometer, a single NaI (Tl) detector and Ge (Li): s. Different nuclei were selected by setting gates on known transitions in the Ge (Li) spectra. The second effective moment of inertia J_{eff}^2 is extracted and compared with values from known discrete γ rays as well as with the results from Cranked Shell Model and a Cranked Nilsson Strutinsky calculations. The systematics of the $i_{13/2}$ neutron orbital is investigated.

22918 (JAERI-M–89-129) **Activation cross section data file, (1).** Yamamuro, Nobuhiro (Data Engineering Inc., Yokohama (Japan)); Iijima, Shungo. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1989. 101p. (In Japanese). (NEANDC(J)–141/U;INDC(JPN)–128/L). Order Number DE90759875. Available from NTIS (US Sales Only), PC A06/MF A01.

To evaluate the radioisotope productions due to the neutron irradiation in fission of fusion reactors, the data for the activation cross sections ought to be provided. It is planning to file more than 2000 activation cross sections at final. In the current year, the neutron cross sections for 14 elements from Ni to W have been calculated and evaluated in the energy range 10^{-5} to 20 MeV. The calculations with a simplified-input nuclear cross section calculation system SINCROS were described, and another method of evaluation which is consistent with the JENDL-3 were also mentioned. The results of cross section calculation are in good agreement with experimental data and they were stored in the file 8, 9 and 10 of ENDF/B format. (author).

22919 (LBL–27840) **Nuclear Science Division annual report for the period October 1, 1987–September 30, 1988.** Mahoney, J. (ed.). Lawrence Berkeley Lab., CA (USA). Oct 1989. 122p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008058. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

Highlights of the low energy research program included the identification of new super-deformed bands in gadolinium and palladium isotopes using the HERA array. Other work at the 88-Inch Cyclotron involved studies of the fragmentation of light nuclei; the spectroscopy of nuclear far from stability and interesting new experiments on the properties of the heaviest elements. Two other programs deserve special mention, the new program in Nuclear Astrophysics and the spectroscopic studies being carried out at OASIS. This isotope separator is now in full operation at the SuperHILAC after many yeas of development. At the Bevalac, important new results were obtained on the properties of hot dense nuclear matter produced in central collisions of heavy ions. First measurements were made using the di-lepton spectrometer which provide the most direct access to the conditions at the earliest stage of the reaction. New results on pion interferometry have been obtained using the Janus spectrometer and surprises continue to be found in careful analysis of data from the Plastic Ball detector, most recently the identification of a new component of hydrodynamic flow. Also at the Bevalac the intermediate energy program continued to grow, studying the evolution of the reaction mechanism from incomplete fusion to the fireball regime, as did the spectroscopic studies using secondary radioactive beams. The third major component of the experimental program is the study of ultra-relativistic nuclear collisions using the CERN SPS. This year saw the completing of analysis of the first round of experiments with important results being obtained on general particle production, the space-time evolution of the system and strangeness production.

22920 (ORNL/TM–11297/R1) **URR [Unresolved Resonance Region] computer code: A code to calculate resonance**

neutron cross-section probability tables, Bondarenko self-shielding factors, and self-indication ratios for fissile and fertile nuclides. Leal, L.C.; de Saussure, G.; Perez, R.B. Oak Ridge National Lab., TN (USA). 15 Feb 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008023. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The URR computer code has been developed to calculate cross-section probability tables, Bondarenko self-shielding factors, and self-indication ratios for fertile and fissile isotopes in the unresolved resonance region. Monte Carlo methods are utilized to select appropriate resonance parameters and to compute the cross sections at the desired reference energy. The neutron cross sections are calculated by the single-level Breit-Wigner formalism with s-, p-, and d-wave contributions. The cross-section probability tables are constructed by sampling by Doppler broadened cross-sections. The various self-shielding factors are computer numerically as Lebesgue integrals over the cross-section probability tables.

22921 (RCNP-P–106) **Proceedings of the workshop on few-body systems.** Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. 161p. (In Japanese, English). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

This issue is the collection of the papers presented at the title meeting. The 28 of the presented papers are indexed individually. (J.P.N.).

6511 Experimental Techniques

Refer also to citation(s) 22872

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

Refer also to citation(s) 22401, 22893

22922 (INIS-mf–11545) **Nucleon multiplicities after pion absorption in ^{16}O.** Hamers, R. Amsterdam Univ. (Netherlands). 12 Jan 1989. 86p. Order Number DE90706037. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The experiment described in this thesis concerns a simultaneous measurement of two- and higher-fold coincidences following positive and negative pion absorption in $_{16}$O. The detected particles are protons, neutrons and deuterons. The detection and analysis of charged particles is discussed. The incident pion energy was 65 MeV, thus well below the delta resonance. The low pion energy was 65 MeV, thus well below the delta resonance. The low pion energy ensures that contributions of initial state interactions, i.e. pion-nucleon scattering preceding absorption, are minimized. The following reaction channels were selected and analysed: (π^+,pp), (π^+,pd). Evidence for quasifree reaction precessed has been investigated by comparing the data with phase-space calculations incorporating the geometry of the experimental setup. 36 refs., 1 fig., 3 tabs.

22923 (INIS-mf–11553) **Ground-state correlations in ^{12}C and the mechanism of the (e,e′p) reaction.** Steenhoven, G. van der. Vrije Univ., Amsterdam (Netherlands). 3 Nov 1987. 148p. Order Number DE90706045. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

In this thesis the results of an investigation into two aspects of the mechanism of the quasi-elastic (e,e′p) reaction: the interaction between the incident electron and the bound proton and the residual nucleus (final-state interaction (FSI)), are presented and used in the extraction of nuclear-structure information from (e,e′p) measurements on ^{12}C. The experiments were carried out at NIKHEF-K with a high resolution spectrometer. Two kinds of experiments have been performed on ^{12}C. The first was aimed at obtaining accurate momentum distributions for various final states in ^{11}B. Some special measurements were carried out in order to vary the parameters influencing the FSI. The role of coupled-channels effects in the ^{12}C(e,e′p)^{11}Be reaction is discussed. It is discussed whether some of the weak transitions observed in this reaction can be associated with knockout from normally unoccupied shell-model orbitals. The second experiment on ^{12}C was devoted to the e-p coupling. These measurements were supplemented with data taken on ^{6}Li. The later measurement allowed for measuring simultaneously knockout from the relatively dense ^{4}He core and the relatively dilute deuteron. In this way the density dependence of the e-p coupling in the nucleus could be studied. The results of these experiments have been compared to various models that take into account the effect of the nuclear medium upon the e-p coupling. The possible role of charge-exchange and meson-exchange currents in the interpretation of these experiments is also considered. A brief survey of the formalism of the quasi-elastic (e,e′p) reaction is also presented. 196 refs., 53 figs., 21 tabs.

22924 (ISN–88-05) **On the spin-orbit deformation in inelastic scattering of polarized protons at intermediate energy.** Swiniarski, R. de; Pham, D.L. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. Jan 1988. 20p. Order Number DE90756409. Available from NTIS (US Sales Only), PC A03/MF A01.

Coupled-channels analyses of both cross-sections and analysing powers data have been performed for low-lying states for ^{16}0(p vector, p), ^{18}0(p vector, p) at 0.8 GeV and ^{12}C (p vector, p') obtained for an energy range between 398 MeV and 697 MeV to study the importance of the deformed Spin-orbit potential. The angular distributions of A_y are very well reproduced only with a full Thomas Spin-orbit potential. The calculations for ^{16}0 and ^{18}0 data have shown that the deformed Spin-orbit term has only minor effect on the inelastic angular distributions and for A_y these calculations strongly suggest that the central and the Spin-orbit deformations should be equal. On the other hand a different behavior is observed for ^{12}C(p vector, p'): first the presence of the deformed Spin-orbit term is essential to reproduce not only analysing power data but also inelastic angular distributions and secondly, for all energies investigated the deformation of the Spin-orbit potential should be greater than that of the central potential.

22925 (JAERI-M–90-012) **Evaluation of neutron nuclear data for ^{16}O.** Shibata, Keiichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Chiba, Satoshi; Nakajima, Yutaka; Asami, Tetsuo; Murata, Toru; Kanda, Yukinori; Tanaka, Shigeya. Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment. c Feb 1990. 32p. (NEANDC(J)–147/U;INDC(JPN)–134/L). Available from Japan Atomic Energy Research Inst., Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

Neutron nuclear data of ^{16}O have been evaluated for JENDL-3 in the energy range from 10^{-5} eV to 20 MeV. Evaluated quantities are the total, elastic and inelastic scattering, (n,2n), (n,γ), (n,p), (n,d), (n,α), (n,np) and (n,nα) reaction cross sections and the angular and energy distributions of emitted neutrons and gamma-rays. The total cross section below 3 MeV was calculated on the basis of the R-matrix theory. The inelastic scattering, (n,np) and (n,nα) reaction cross sections were obtained from the statistical model calculation. The gamma-ray production cross section was also calculated with the statistical model. 39 refs., 18 figs., 4 tabs.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

22926 (CONF-900147–2) **Populations of excited states and reaction mechanisms in the emission of complex fragments.** Gomez del Campo, J. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 13. symposium on nuclear physics; Oaxtepec (Mexico); 3-6 Jan 1990. Order Number DE90007481. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Cross sections for emission of complex fragments (Z>2) in their ground and excited states are presented for several heavy-ion reactions at bombarding energies above 10 MeV/nucleon. Data presented are mostly on the cross sections extracted by γ-ray techniques. It is shown that a simple statistical approach to associate the ratio, of cross sections for excited states and ground states, to the temperature of the emitter fails to give the expected temperatures. However, it is shown that this is mostly due to the

fact that the fragments that γ decay are secondary fragments, produced by the particle decay of the primary emitted complex fragments. A Hauser-Feshbach analysis accounts well for the cross sections and extracted temperatures. 22 refs., 6 figs.

22927 (KURRI-TR–318, pp. 30-34) **Measurements of X-rays and low-energy β-rays with a liquid scintillation counter.** Furukawa, M. (Nagoya Univ. (Japan). Faculty of Science). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. LIQUID SCINTILLATION DETECTORS/x-ray detection; LIQUID SCINTILLATION DETECTORS/beta detection; IRON 55; NICKEL 63; SENSITIVITY; SCINTILLATION QUENCHING; EXPERIMENTAL DATA

22928 (UCRL–101772) **Nuclear structure effects in exciton level densities.** Blann, M. Lawrence Livermore National Lab., CA (USA). Oct 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911128–5: NEANDC specialists' meeting on level densities, Bologna (Italy), 15-17 Nov 1989). Order Number DE90008351. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We summarize experimental (p,n) spectra which illustrate nuclear structure effects in the precompound spectra for nuclei in the A=60 and A=90 regions. Results of spectra calculated using the Williams method of computing few quasiparticle densities are compared with data using three different sets of single particle levels including recent results due to Moller and Nix. Attention is drawn to the importance of angular momentum coupling in determining the final structure of the experimental spectra. 10 refs., 8 figs.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 22927, 22928

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 22873, 22926, 22928

22929 (DOE/ER/10495–3) **Study of transitional nuclei at TRISTAN: Progress report.** Petry, R.F. Oklahoma Univ., Norman, OK (USA). [1983]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-79ER10495. Order Number DE90007668. Available from NTIS, PC A02/MF A01; OSTI; INIS.

At present there are six decay studies at TRISTAN in which the Oklahoma group has a major participation. These involve the decay of ^{99}Sr, ^{145}Ca, ^{147}La, ^{99}Rb, ^{101}Sr and ^{101}Y. These projects are in varying stages of completion and will be discussed individually in this paper. During the first third of this contract year (6/1/82–10/1/82) time at TRISTAN was devoted to ion-source and other facility development. Two new ion sources were developed and tested, a surface ionization source with a Ta ionizer and a FEBIAD-type plasma source. Both worked very well and with excellent reliability. In addition some work was done toward developing a surface ionization ion source for negative ions of Br and I, which are of special interest to the Oklahoma project. Further development of this source was postponed in favor of production runs with the other two, and a variety of new possibilities for future work have become available from these sources.

22930 (KURRI-TR–318, pp. 83-86) **Decays of ^{147}Ba and ^{147}La using KUR-ISOL.** Aoki, K. (Himeji Inst. of Tech., Hyogo (Japan)); Okano, K.; Kawase, Y. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. BARIUM 147/nuclear decay; LANTHANUM 147/nuclear decay; CESIUM 147; GAMMA SPECTRA; COINCIDENCE SPECTROMETRY; INTERNAL CONVERSION; EXCITED STATES; EXPERIMENTAL DATA

22931 (UCRL–98618) **In-beam studies of ^{96}Zr and ^{98}Zr: Collective excitations.** Henry, E.A. (Lawrence Livermore National Lab., CA (USA)); Meyer, R.A.; Aprahamian, A.; Mann, L.G.; Roy, N.; Maier, K.H. Lawrence Livermore National Lab., CA (USA). 18 Apr 1988. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8804119–5: International workshop on nuclear structure of the zirconium region, Bad Honnef (Germany, F.R.), 24-28 Apr 1988). Order Number DE90008358. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Nearly two decades ago signatures of deformation in the ground state bands of ^{100}Zr and ^{102}Zr were identified, and the rapid change in the deformation of heavy zirconium nuclei noted. It is now well accepted that the short-range proton-neutron interaction between the $1g_{9/2}$ and $1g_{7/2}$ spin-orbit partners plays an important role in producing ground state deformation in this region. Nevertheless, recent studies of zirconium nuclei, including those in the transition region, continue to refine our understanding of the interplay between single-particle and collective degrees of freedom. In this report we discuss some aspects of the level structures of ^{96}Zr and ^{98}Zr with emphasis on collective excitations. 18 refs., 2 tabs.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 22231

6530 Nuclear Theory

Refer also to citation(s) 22818, 22873, 22919

22932 (CLM-R–295) **A neutron activation, transmutation and dose rate benchmark study.** Sublet, J.Ch. (UKAEA Culham Lab., Abingdon (UK)); Mann, F.M.; Ponti, C. UKAEA Culham Lab., Abingdon (UK). Sep 1989. 42p. Available from H.M. Stationery Office, London, price Pound 10.00. Available from H.M. Stationery Office, London, price Pound 10.00.

Deuterium-Tritium (D-T) plasmas are strong sources of 14 MeV neutrons, which are transmitted through the different components of the fusion reactor. During this process they induce activity by transmutation reactions in the structural materials. Three different computer code systems for predicting induced activation and transmutation reactions have been implemented with the same input data appropriate to JET conditions in order to compare their predictions. The results of this benchmark comparison show, in general, fairly close agreement. However, differences of up to a factor 84 could appear between the predictions of the induced activity of the different codes for specific radionuclides. In the case of some shorter-lived radionuclides the lack of agreement could be due to differences in the decay data, whilst for the better-known and less numerous long lived isotopes the differences are associated with variations in the cross section data for those isotopes. (author).

22933 (CRN-PN–8803) **High spin levels populated in multinucleon transfer reaction with 480 MeV ^{12}C.** Kraus, L. (and others); Boucenna, A.; Linck, I. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires; Strasbourg-1 Univ., 67 (France). 1988. 36p. Order Number DE90756410. Available from NTIS (US Sales Only), PC A03/MF A01.

Two- and three-nucleon stripping reactions induced by 480 MeV ^{12}C have been studied on ^{12}C, ^{16}O, ^{28}Si, ^{40}Ca and ^{54}Fe target nuclei. Discrete levels are fed with cross sections up to 1 mb/sr for d-transfer reactions and one order and two orders of magnitude less for 2p- and ^{3}He-transfer reactions, respectively. These reactions preferentially populate high spin states with stretched configurations. Several spin assignments were known from transfer reactions induced by lighter projectiles at incident energies well above the Coulomb barrier. In the case of two-nucleon transfer reactions, the energy of these states is well reproduced by crude

shell model calculations. Such estimates are of use in proposing spins of newly observed states especially as the shapes of the measured angular distributions are independent of the final spin of the residual nucleus.

22934 (DOE/ER/40264–4) **Theoretical research in nuclear structure and nuclear collective motion: Progress report, March 1, 1989–February 28, 1990.** Klein, A. Pennsylvania Univ., Philadelphia, PA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER40264. Order Number DE90008427. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The work described in this report falls into two main categories, large amplitude collective motion and boson mappings of Lie algebras for use in nuclear physics.

22935 (GANIL-P–87-27) **Collision effects on the nuclear dynamics.** Gregoire, C. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1987. 71p. (In French). Order Number DE90756358. Available from NTIS (US Sales Only), PC A04/MF A01.

The lectures on the collision effects on the nuclear dynamics are reported. A kinetic equation, describing the nuclear dynamics in a microscopical way, is deduced. The Vlasov equation and methods, allowing the obtention of approached solutions, are indicated. Concerning one dimensional and spherical symmetric systems, these solutions applied to the matter slab collisions and to the expansion of the excited spherical cores, are discussed. Moreover, the phenomenology of the collision terms and their application on the heavy ions collisions, are considered. The respective parts of the mean field and the collision term in different cases, are indicated. A link with the transport theories is given by the calculations of dispersions and by means of the Landau-Vlasov equation.

22936 (GSI–89-31) **Electron-positron angular correlation in the pair conversion.** Hofmann, C. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Inst. fuer Theoretische Physik. Dec 1989. 92p. (In German). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

The angular correlation in the pair conversion was calculated with Coulomb-deformed scattering waves for the electron wave functions. The angular correlation for the E0 conversion agrees for high nuclear transition energies and nuclear charges $Z < 100$ well with the already known angular correlation obtained in Born approximation. Going to lower transition energies and extremely high nuclear charges larger differences to the Born approximation are present. (orig./HSI).

22937 (IPNO-TH–87-52) **Signals of a phase transition in nuclear breakup.** Campi, X. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1987. 7p. (CONF-871243–: Symposium on hot nuclei, College Station, TX (USA), 7-10 Dec 1987). Order Number DE90756442. Available from NTIS (US Sales Only), PC A02/MF A01.

We show that nuclei break up like finite systems that exhibit a clean phase transition in infinite size. This is done by studying conditional moments of the fragment multiplicities, the largest fragment size produced by event and its fluctuations. The nature of this smooth phase transition cannot be determined from the available experimental data. The "critical point" is reached when the energy deposited in the nucleus is 90% of its binding energy.

22938 (ISN–87-90) **Short range correlations: few-body systems.** Silvestre-Brac, B. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. 1987. 78p. (In French). (CONF-8709402–: The Joliot-Curie 1987 nuclear physics school, Maubuisson (France), 14-18 Sep 1987). Order Number DE90756445. Available from NTIS (US Sales Only), PC A05/MF A01.

In these lectures, we present the correlations in few-body systems. The probability densities for quarks inside a baryon and for nucleons inside a nucleus are commented in detail and reported on a number of photos. The emphasis is put on the link between the forces acting upon quarks and the forces acting upon nucleons. Several systems are analysed carefully: the diquarks, the baryons, the N-N interaction, the H dibaryon and the nuclei ^{2}H, ^{3}H, ^{4}He.

22939 (ISN–8810) **On the role of quantum tunneling and statistical effects in the liquid gas phase transition of hot nuclei.** Blin, A.H. (Institut fuer Theoretische Physik, Regensburg Univ. (DE)); Hiller, B.; Reinhard, H.; Schuck, P. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. Jan 1988. 39p. Contract de Br 733/4-1. Order Number DE90756454. Available from NTIS (US Sales Only), PC A03/MF A01.

The triggering of the liquid-gas phase transition in hot nuclear matter by quantum and statistical fluctuations is studied in a microscopic approach to nucleation which is a fluid-dynamical version of the imaginary-time dependent mean-field theory at finite temperature. It is found that quantum tunnelling processes are only important below T = 1 MeV.

22940 (JAERI-M–90-006) **A nuclear cross section calculation system with simplified input-format: Version 2, (SINCROS-II).** Yamamuro, Nobuhiro. Japanese Nuclear Data Committee, Tokai, Ibaraki (Japan). c Feb 1990. 64p. (NEANDC(J)–146/U;INDC(JPN)–133/L). Available from Japan Atomic Energy Research Institute, Dept. of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

A Nuclear Cross Section Calculation System with Simplified Input-Format, Version-II (SINCROS-II) has been developed by improving the functions of the program in SINCROS-I, and preparing some process codes for the cross section applications. There is the option of optical-model potentials for neutron and proton, and the capture cross section normalization to the experiment and the width fluctuation correction to compound nuclear cross section become possible. The method recommended for nuclear cross section calculation is described. This system will be used to estimate the cross sections of nuclei for which the experimental data do not exist. 39 refs., 40 figs., 7 tabs.

22941 (N–90-14890) **Calculation of two-neutron multiplicity in photonuclear reactions.** Norbury, J.W.; Townsend, L.W. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jan 1990. 11p. (NASA-TP–2968;L–16610;NAS–1.60:2968). Available from NTIS, PC A03/MF A01.

The most important particle emission processes for electromagnetic excitations in nucleus-nucleus collisions are the ejection of single neutrons and protons and also pairs of neutrons and protons. Methods are presented for calculating two-neutron emission cross sections in photonuclear reactions. The results are in a form suitable for application to nucleus-nucleus reactions.

22942 (UCRL–101262) **Precompound decay models for medium energy nuclear reactions.** Blann, M. Lawrence Livermore National Lab., CA (USA). Nov 1989. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891103–67: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90008352. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The formulations used for precompound decay models are presented and explained in terms of the physics of the intranuclear cascade model. Several features of spectra of medium energy (10–1000 MeV) reactions are summarized. Results of precompound plus evaporation calculations from the code ALICE are compared with a wide body of proton, alpha, and heavy ion induced reaction data to illustrate both the power and deficiencies of predicting yield of these reactions in the medium energy regime. 23 refs., 13 figs.

22943 (UCRL–102806) **N-p bremsstrahlung in heavy ion collision processes.** Blann, M. Lawrence Livermore National Lab., CA (USA). 16 Jan 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900179–1: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). Order Number DE90008542. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The goal of this presentation is to summarize the current status of the interpretation of energetic γ-rays in heavy ion collisions via the n-p-bremsstrahlung mechanism. An essential element of the

topic is a transport equation to approximate the fast non-equilibrium nucleon-nucleon cascade/emission stage of the heavy ion reactions. It is during this stage that we expect the n-p-bremsstrahlung processes to produce energetic photons. I shall begin with a very brief description of the Boltzmann master equation (BME) model which will be used as the transport code, deferring to earlier works for a more complete description, and present but a single representative comparison with an experimental neutron emission spectrum. I shall then summarize the status of the elementary n-p-γ cross section needed to extend the transport code to photon emission in heavy ion reactions, and summarize the status of these comparisons with data. 29 refs., 4 figs.

22944 (UCRL–102923) **Microscopic optical model calculations of nucleon-nucleus scattering over wide mass and energy rates.** Hansen, L.F. Lawrence Livermore National Lab., CA (USA). 9 Feb 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909300–2: International school on nuclear physics, neutron physics and nuclear energy conference, Varna (Bulgaria), 29 Sep - 7 oct 1989). Order Number DE90008546. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Microscopic optical model potentials are tested against a large body of measurements of elastic differential cross sections and analyzing powers for neutrons (8–40 MeV) and protons (16–60 MeV) scattered from targets ranging from ^{6}Li to ^{208}Pb. Reasonably good fits to the data can be found using only three parameters, λ_V, λ_W and λ_{SO}, normalizing constants to the real, imaginary and spin orbit potential, respectively. These parameters have a smooth dependence on energy and mass number. 17 refs., 8 figs.

6540 Radiation and Shielding Physics

Refer also to citation(s) 22397, 22858, 22859, 22860, 22920

22945 (BNL–43872) **Neutrons: The kinder, gentler probe of condensed matter.** Axe, J.D. Brookhaven National Lab., Upton, NY (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891119–110: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90008511. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Neutrons play an increasingly important role in the characterization of advanced modern materials. They provide information that complements rather than competes with that provided by other scattering probes. Although neutrons require heroic efforts to produce, the techniques for using them are not particularly difficult, and with the advent of sufficient user friendly facilities, are becoming a routine tool in the arsenal of expanding numbers of materials scientists. 10 refs., 5 figs.

22946 (ECN–216) **User's guide for the small-angle neutron scattering facility.** Vlak, W.A.H.M.; Werkhoven, E.J. Netherlands Energy Research Foundation, Petten (Netherlands). Apr 1989. 79p. Order Number DE90706032. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This report serves as a manual for the users of the small-angles neutron scattering instrument located at beamport HB3 of the High Flux Reactor in Petten. The main part of the text is devoted to the control of the facility and the data handling by means of a μVAX computer. Also, the various possibilities to access the facility across computer networks are discussed. A collection of menu-driven and command-driven programs, which utilize the flexibility of the VMS operating system without requiring detailed knowledge of the user about the computer environment, enables to control the instrument. For the convenience of the experienced user, who might wish to update or extend the software, a technical supplement is included. 8 refs., 15 figs.

22947 (KEK–89-13) **The 2nd KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons.** Yoshiki, H. (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. 137p. (In Japanese). (CONF-8903201–: 2. KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons, Tsukuba (Japan), 11 Mar 1989). Order Number DE90760025. Available from NTIS (US Sales Only), PC A07/MF A01.

This issue is the collection of the papers presented at the title symposium. The 15 of the presented papers are indexed individually. (J.P.N.).

22948 (KURRI-TR–318, pp. 22-25) **A method of intensity determination of γ-rays emitted from weak short-lived radioactive sources.** Baba, H. (Osaka Univ., Toyonaka (Japan). Faculty of Science). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. GAMMA DETECTION/ge semiconductor detectors; EUROPIUM 152; PHOTOELECTRON COUNTING; GAMMA CASCADES; EXPERIMENTAL DATA

22949 (LAL–88-55) **Transition radiation.** Fayard, L. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. Nov 1988. 14p. (CONF-8809411–:). Order Number DE90756405. Available from NTIS (US Sales Only), PC A03/MF A01.

Theoretical description, properties and applications of the radiation produced by a charged particle, passing through the interface between two different dielectric media, is given. Equations for normal and oblique incidence, and for the vacuum-medium transition are described. The case of non relativistic limit, the length of formation zone, as well as the Wartski interferometer formulas are considered. Results for ultra-relativistic charged particles with a multifoil radiator and an X-ray detector are presented. The forward and backward radiation case, the transition radiation produced by a single foil and by a periodic radiator are described. The procedure to optimize the parameters of a detector device is given.

22950 (PNL–6100-Pt.4, pp. 21-22) **Doubly differential ionization cross sections for intermediate-velocity heavy ions.** Goldhagen, P.; Toburen, L.H.; DuBois, R.D. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The interaction of fast neutrons in tissue results in the production of recoil ions that deposit energy along densely ionizing charged particle tracks. Although a great deal of information exists regarding ionization by the recoiling of protons and by nuclear reaction induced alpha particles, little is known about the detailed ionization cross sections for the heavier recoil ions (such as carbon, oxygen, and nitrogen) that also may be produced by interactions of neutrons in tissue. Measurements were conducted for oxygen ion energies from 1.3 to 3.3 MeV. The cross sections for emission of low-energy electrons increase as the ion charge state increases. The interaction strength is proportional to its net charge. For high-energy ejected electrons similar cross sections are expected for all charge states. However, a clear decrease was shown in the cross sections for electrons ejected with energies higher than about 500 eV by the higher-charged ions compared to electrons of similar energy that are ejected by lower-charged ions. For intermediate- to low-energy ion collisions it may be speculated that the emission cross sections should depend more on the kinetic parameters of the collision and the total number of electrons involved than on the detailed atomic or molecular structure of the colliding partners. Because outer-shell ionization involves numerous potential curve crossings, rearrangement on a statistical basis would be expected with individual states losing their identity relative to the observed electron spectra. If this concept has any validity, similar electron spectra and yields would be expected to be produced by collision systems of similar relative velocities and total electron number.

22951 (RAL–89-104) **Final state effects in deep inelastic neutron scattering.** Mayers, J. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 29p. Order Number DE90619118. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new formulation of final state effects (FSE) in deep inelastic neutron scattering (DINS), which allows for simple intuitive interpretations is presented. It is shown that at high momentum transfer q, FSE can be formulated in terms of a single function $\phi_\omega(r)$, where r is the position coordinate of the struck atom and the functional form of ϕ_ω depends only on ω, the energy transfer. It follows from this formulation that if final state effects are represented as a convolution of a broadening function R, with the impulse approximation prediction for $S(q,\omega)$, R depends strongly on the form of the atomic momentum distribution. Previous treatments which formulate FSE in superfluid He4 in terms of R, but which neglect the presence of the Bose condensate in the calculation of R, are inconsistent and underestimate final state broadening of the condensate. It is predicted that incoherent scattering from the Bose condensate is negligible and suggested that the condensate makes a finite contribution to $S(q,\omega)$ via coherent scattering at all q. A simple argument is presented, which shows, that FSE in quantum fluids are significant at all attainable momentum transfers. (author).

6550 Medical Physics

Refer also to citation(s) 21745, 21801, 22451, 22582, 22749, 23213

22952 (DOE/ER/60707–2) **Considerations of beta and electron transport in internal dose calculations: Progress report.** Poston, J.W. Sr. (Texas A and M Univ., College Station, TX (USA). Dept. of Nuclear Engineering); Bolch, W.E. Texas A and M Univ., College Station, TX (USA). Research Foundation. 26 Feb 1990. 148p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER60707. Order Number DE90008413. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

A computer program has been developed at Texas A & M University to model the transport and energy deposition of electrons and photons for use in internal dose estimation. The code incorporates photon and electron transport subroutines with the geometry subroutine from ALGAM. A user code, called INDOSE, was used to provide estimates of the absorbed fraction of energy for selected target organs of a mathematically described human phantom. The INDOSE code is comprised of three primary sections: the MAIN program, AUSGAB, the scoring routine, and POSITIN, the geometry tracking routine. The geometry routine contains a mathematical representation of Reference Man. The total-body phantom consists of three principal sections and of three types of tissue: lung, skeletal tissue, and soft tissue. The skeletal system represents the total content of the intact skeleton and includes both bone and marrow. This material is considered to be distributed homogeneously throughout the phantom. In 1988, a research proposal was submitted to the Department of Energy (DOE) to continue the code development for use in internal dosimetry calculations, particularly those related to diagnostic nuclear medicine procedures. This document presents a progress report for the completion of tasks accomplished over the period of July 1989 through January 1990. 39 refs., 45 figs., 24 tabs.

22953 (DOE/ER/60867–1) **Macrodosimetry and microdosimetry in radioimmunotherapy: Progress report, July 15, 1989–July 14, 1990.** Leichner, P.K. Johns Hopkins Oncology Center, Baltimore, MD (USA). Feb 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60867. Order Number DE90007366. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This progress report summarizes the research accomplished and its clinical implementation since July 15, 1989. To improve beta-particle dosimetry, a point-source function was developed that is valid for a wide range of beta-particle emitters. An analytical solution for beta-particle dose rates within and outside of slabs of finite thickness was validated in an experimental tumor system and is now being used in clinical radioimmunotherapy (RIT). Quantitative SPECT was validated in phantom studies, beagle dogs, and patients with Kaposi's sarcoma. It is currently being used in clinical RIT for patients with Hodgkin's disease or hepatoma. Additionally, methodologies and computer software are being developed for quantitative autoradiography to achieve absorbed-dose calculation on the cellular level. 7 refs., 1 tab.

22954 (STUK-A–81) **Radioactivity of people in Finland in 1987: Supplement 7 to annual report STUK-A-74.** Rahola, T.; Suomela, M.; Illukka, E.; Pusa, S. Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Aug 1989. 69p. Order Number DE90619708. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The atmospheric nuclear bomb tests in the 1950s, '60s and '70s caused global radioactive fallout. After the reactor accident at Chernobyl on April 26, 1986, radioactive fallout was carried by by air streams to most parts of Europe. In 1987 radionuclides causing internal contamination were transported to man only via different foodchains and no longer via inhalation, as had happened immediately after the Chernobyl accident. To determine the level of radionuclides in the body and to estimate the internal radiation doses caused by the Chernobyl accident, whole-body counting measurements were performed. Ten different groups of people were measured during 1987. Three were local reference groups, two groups of radiation workers, one a population group representing the whole country and four groups representing those with special dietary habits. The weighted mean ^{137}Cs body burden in the population group was 2000 Bq at the end of 1987, the minimum body burden being 200 Bq and the maximum 10000 Bq. The measurement results showed that the maximum body burdens were reached in the summer 1987. The groups with special diets did not necessarily follow this pattern. The mean effective dose equivalents delivered in 1987 to people in Finland, estimated by using the measurement results of the population group, was 0.08 mSv, the corresponding dose equivalent in 1986 bein 0.06 mSv.

6560 Condensed Matter Physics

Refer also to citation(s) 22107, 22158, 22193, 22333, 22374, 22400, 22865, 22868, 22869, 22870, 22871, 22945, 22973, 22974, 23181

22955 (CEA-CONF–9816) **Conformal invariance self-avoiding walks in the plane or on a random surface.** Duplantier, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 17p. (CONF-8806456–: Meeting on fields, strings and critical phenomena, Les Houches (France), 28 Jun - 5 aug 1988). Order Number DE90756364. Available from NTIS (US Sales Only), PC A03/MF A01.

The two-dimensional (2D) properties of polymers embedded in a solvent, are studied. They are modeled on a lattice by self-avoiding walks. The polymer properties either in the plane with a fixed metric, or on a random 2D surface, where the metric has critical fluctuations, are considered. In the scope of the work, the following topics are discussed: the watermelon topology; the O(n) model and Coulomb gas technique; the model and critical behaviours of polymers on a two-dimensional random lattice; the conformal invariance in a random surface and higher topologies.

22956 (CONF-8909210–6) **Collective aspects of charged particle track structure.** Basbas, G. (Physical Review Letters, Ridge, NY (USA)); Howie, A.; Ritchie, R.H. Oak Ridge National Lab., TN (USA). [1989]. 21p. Sponsored by U.S. DOE Energy Research; North Atlantic Treaty Organization; National Science Foundation. DOE Contract AC05-84OR21400. From 12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989. Order Number DE90008406. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A plasmon generated by a swift charged particle constitutes a coherent excitation about the particle track. We discuss the representation of collective modes in impact parameter space when created by a swift ion or a fast electron, and the decay of these modes into localized excitations. Several alternative spatial representations are considered. We show that the high spatial resolution found in secondary electron emission measurements with scanning electron microscopy is consistent with the existence of the plasmon as an intermediary between the fast incident electron and the measured secondary electrons. 24 refs., 6 figs.

22957 (CONF-8909210–7) **Bremsstrahlung Induced by 50 MeV H° bombardment.** Stein, C. (Air Force Weapons Lab., Kirtland AFB, NM (USA)); Habiger, K.W.; Smith, B.R.; Crawford, O.H.; Ritchie, R.H. Oak Ridge National Lab., TN (USA). [1989]. 16p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Contract 1418-1418-A1. From 12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989. Order Number DE90008410. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three different thicknesses of aluminum targets, 0.0025 cm, 0.025 cm, and 0.32 cm were irradiated with 50-MeV neutral hydrogen atoms and the resultant bremsstrahlung radiation measured. The experimental results are compared with calculations that include bremsstrahlung by the projectile's electron and its cascade, bremsstrahlung by the cascade electrons that are generated by the projectile nucleus and quasifree-electron bremsstrahlung. The theoretical and experimental values of the total yield agree within a factor of three for all target thicknesses and all bremsstrahlung energies. 16 refs., 4 figs.

22958 (DOE/ER/13441–6) **Interactions of molecules with surfaces: Progress report, February 1989–January 1, 1990.** Greene, E.F. Brown Univ., Providence, RI (USA). Jan 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13441. Order Number DE90007555. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This is a report of the progress made on four projects supported by DOE Grant FG02-85ER13441 in the period 1 February 1989 to 31 December 1989. A long term study of the rate of transfer of electrons between gas atoms and the surfaces of crystals, using the technique of surface ionization, reached a point where it could be submitted for publication. Measurement of the energy dependence of the yields of Na^+, K^+, and Cs^+ ions formed when beams of the corresponding alkali atoms M hit a Si(111) surface and of Na^+ for Na striking a Pt surface at a temperature T are those expected for equilibrium for thermal kinetic energies of the incident atoms. Energy transfer to surfaces has been studied by measuring the temperature rises of thermocouple surfaces exposed to molecular beams. He diffraction has been used to follow structural phase transitions on the (111) and (100) surfaces of Si and Ge. Work is in progress to measure the effect of adsorbed atoms on the forces parallel to the surface of a crystal as they are revealed by changes in the curvature of the surface. The first experiments are being done with alkali atoms adsorbed on a Si(111) surface.

22959 (DOE/ER/13674–3) **Theoretical studies of electrons and electron transfer processes in fluids: Final progress report, February 1987–August 1989.** Kestner, N.R. Louisiana State Univ., Baton Rouge, LA (USA). Dept. of Chemistry. [1989]. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER13674. Order Number DE90008414. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research accomplished during this grant involved studies of (1) Interaction of hydrated metal ions. Studies with accurate model potentials have demonstrated the distortion of hydration shells at high concentrations. (2) Water-water interactions and weak intermolecular forces. The Basis Set Superposition Error (BSSE) limits the accuracy of intermolecular potentials. (3) Negative polar clusters. We have developed the pseudopotential for ammonia with Landman and Jortner and have collaborated in published studies of negative ammonia clusters. (4) Density functional theory. A very large calculation on the iron dimer has been published; other work on the interaction of argon atoms has been completed. Work on CO_2, cobalt and the ionization potential of various transition metal ions has been completed. (5) Sodium water clusters. Our work on these clusters which have been observed experimentally in beams has been published. These may also be involved in photobleaching hydrated electrons. Collaborative work using path integral methods and Fast Fourier Transform methods are underway to obtain the excited states. (6) Propane interactions. In collaboration with Dr. S. Gupta we have studied the interaction of propane molecules and used these to evaluate its liquid properties. (7) Conducting polymers. Our work on the conformation of several conducting polymer fragments has been published.

22960 (DOE/ER/45125–T2) **Studies of the structure and properties of organic monolayers, multilayers and superlattices: Progress report, January 1987–January 1990.** Dutta, P.; Ketterson, J.B. Northwestern Univ., Evanston, IL (USA). Dept. of Physics and Astronomy. 1990. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45125. Order Number DE90008330. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Organic monolayers and multilayers are both scientifically fascinating and technologically promising; they are, however, both complex systems and relatively inaccessible to experimental probes. In this progress report, we describe our x-ray diffraction studies, which have given us substantial new information about the structures and phase transitions in monolayers on the surface of water; our use of these monolayers as a unique probe of the dynamics of wetting and spreading; and our studies of monolayer mechanical properties using a simple but effective technique available to anyone using the Wilhelmy method to measure surface tension. 20 refs., 11 figs.

22961 (DOE/ER/45405–1) **The geometry of disorder: Report 1987–1990.** Henley, C.L. (Cornell Univ., Ithaca, NY (USA)). Boston Univ., MA (USA); Cornell Univ., Ithaca, NY (USA). [1990]. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER45405;FG02-87ER45323. Order Number DE90008250. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is organized into four sections by topic. Each section and subsection has an introduction, followed by summaries of each publication. Summaries of works in progress, with expected completion by July 1, are included labeled by the item number in the list at the bottom of the publications list. This paper includes work on the geometry, i.e. how are structural units packed together in space, including the single most significant accomplishment under this grant: the development of the "random tiling" picture of quasicrystal ordering. This is followed by quasicrystal atomic structure (including work on quasicrystal faceting). Then I turn to random frustrated magnetic systems, where we have worked out ground state selection – "ordering due to disorder" – in some 2D model systems, and are currently studying the Wolff Monte Carlo algorithm. finally I summarize results on a new "self-organized percolation" model with a non-equilibrium dynamics representing "epidemics", "forest fires", or other self-catalytic reactions.

22962 (IPNO-T–88-01) **Experimental study on the secondary emission (atomic and molecular ions, aggregates, electrons) induced by the bombardment of surfaces by means of energetic heavy ions (≈ MeV/u). Effects of the charge state of the projectiles.** Monart, B. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire; Paris-7 Univ., 75 (France). May 1988. 160p. (In French). Order Number DE90756356. Available from NTIS (US Sales Only), PC A08/MF A01.

The ionic and electronic emissions, induced by the sputtering of solid targets (organic and inorganic) with 1 MeV/u projectiles. The time-of-flight spectrometry is applied to the secondary emission analysis. The projectile velocity, the angle of attack (between the beam and the target), and the projectile's incident charge state, are taken into account. It is shown that the secondary emission depends on the charge of the incident ion and on the charge state changement in the material's bulk. A model, applying the theoretical calculations concerning the charge in the material's bulk, is proposed. The existence of an interaction depth, for the incident ion and the material, which depends on the secondary ions type and on the incident ion charge, is suggested. The calculated depth is about 200 angstroms for the aggregates ejected from a CsI target, sputtered with $^{14}Kr^{18+}$. The H^+ yield (coming from ≈ 10 angstroms) is used as a projectile charge probe, at the material surface. The exprimental method allows, for the first time, the obtention of the equilibrium charge state in the condensed matter. The same method is applied to determine the non-equilibrium charges in the bulk of thin materials. The results show that, after leaving the material, the projectile presents a post-ionization state.

22963 (KURRI-TR–318, pp. 40-42) **Construction of an ion-trap for laser nuclear spectroscopy.** Fujioka, M. (Tohoku Univ., Sendai (Japan). Cyclotron and Radioisotope Center). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In

Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. LASER SPECTROSCOPY/ trapping; TRAPPING; CONSTRUCTION; PENNING ION SOURCES; HYPERFINE STRUCTURE; DYE LASERS; MASS SPECTROMETERS; ULTRAHIGH VACUUM; LASER RADIATION; ION BEAMS

22964 (KURRI-TR–318, pp. 95-99) **Life-time measurements of nuclear excited states in low energy region using an LEPS.** Miyachi, M. (Nagoya Univ. (Japan). Faculty of Engineering); Osa, A.; Shibata, M. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. EXCITED STATES/lifetime; LIFETIME; MEASURING METHODS; NUCLEAR STRUCTURE; ENERGY LEVELS; BARIUM 125; BARIUM 127; GAMMA SPECTRA; ENERGY DEPENDENCE; HALF-LIFE; TIME RESOLUTION; GE SEMICONDUCTOR DETECTORS

22965 (LBL–27522) **Absolute pressure dependence of the second ionization level of EL2 in GaAs.** Bliss, D.E.; Walukiewicz, W.; Nolte, D.D.; Haller, E.E. Lawrence Berkeley Lab., CA (USA). Nov 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119–104: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007761. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report the results of DLTS experiments under uniaxial stress on the second ionization level of EL2(++/+) in p-type GaAs. We measured the shift in the hole emission rate as a function of stress applied in the [100] and [110] directions. By modeling the valence band with two independently displacing bands and appropriately derived effective masses, we obtain a small absolute hydrostatic pressure derivative for the defect, 39 ± 15 MeV GPa^{-1}. The shear contribution is negligible. This result is very different than for the first ionization level, EL2(+/o) with a emission energy pressure derivative of 90 ± 15 MeV GPa^{-1}. The difference can be accounted for by the pressure dependence of the electron capture barrier of EL2(+/o), 49 ± 15 MeV GPa^{-1}. The absolute pressure derivatives of the two levels are then comparable and in good agreement with simple theory for Ga site point defects. 20 refs., 2 figs.

22966 (LYCEN-T–88-09) **Stimulated desorption induced by hydrogen aggregates (E $\leq$120 keV/u) and by heavy ions (E $\leq$ 400 keV/u). Analytical applications.** Oladipo, A. Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire. Mar 1988. 106p. (In French). Order Number DE90756360. Available from NTIS (US Sales Only), PC A06/MF A01.

This work presents an original group of results on stimulated desorption induced by H_n^+ clusters (n up to 61) at 600 keV on insulating samples. This phenomenom has been applied to surface microanalysis using both these particles and MeV argon ions. A time of flight spectrometer is used for the secondary ion detection. As far as clusters are concerned and for CsI material it is shown that the Cs^+ yield varies quadratically with the stopping power for these cluster, both above and below the BOHR velocity, v_0. Such a trend is based on a coherent interpretation of the role of collective and individual interactions leading to the energy deposit. The study of H^+ variation is not only in agrement with this interpretation but also gives some new informations on the interaction below v_0. As for the organic material, phenylalanine, we show the qualitative applicability of the model of intact molecule desorption from the periphery of the primary particle track. The high values of the measured ion yields (up to 100%), allows the use of low intensity ion beams using collimators of 2 μm diameter. The optimum lateral resolution has not been obtained with clusters due to technical limitations, but with the Ar ion irradiation system; a value of 10 μm has been obtained. On the other hand, marked differences have been observed between various alkali compounds, for which we make a tentative interpretation. Finally the evolution of desorption yields with the particle fluence constitutes an insight into the role played by the energy density on material modification under irradiation.

22967 (RAL–89-107) **High energy magnetic neutron scattering in heavy fermion compounds.** Osborn, R. (Rutherford Appleton Lab., Chilton (UK)); Taylor, A.D.; McEwen, K.A.; Goremychkin, E.A. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 8p. (CONF-890953–: International conference on the physics of highly correlated electron systems, Santa Fe, NM (USA), 11-15 Sep 1989). Order Number DE90618499. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

To be published in Physica B.

High energy magnetic inelastic neutron scattering measurements of intermultiplet transitions in rare earth and actinide metals have established the importance of intra-atomic correlations even in the presence of strong hybridisation. Well defined transitions are observed up to an energy of 1766 meV in thulium metal. The $^3H_4 \rightarrow {}^3F_2$ transition is observed across the alloy series $U(Pd_{1-x}Pt_x)_3$, showing that localised $5f^2$ excitations persist in the heavy fermion compound UPt_3. The splitting of the spin-orbit transition in $CeAl_3$ suggests that hybridisation is an important component in the crystal field potential. (author).

22968 (UCRL–98747) **A unified integrated model for sputter coating uniformity.** Upadhye, R.S.; Hsieh, E.J. Lawrence Livermore National Lab., CA (USA). 9 Aug 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891093–26: 36. American Vacuum Society national vacuum symposium, Boston, MA (USA), 23-27 Oct 1989). Order Number DE90008322. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The coating flux received by substrates in a sputter coating process consists of two components: the diffusive flux, contributed by fully thermalized atoms, and the directed flux, contributed by atoms which have retained a major part of their original velocity (i.e., both speed and direction). Near the source, the directed flux prevails, whereas far away from the source, the diffusive flux dominates. The sputtered source atoms undergo collisions with the inert gas atoms and become thermalized. The fraction of thermalized atoms increases with distance from the source, and so does the diffusive component of the net flux. The two different process mechanisms have often been modeled separately. Such models work only in the extremes, and are not useful in situations where both mechanisms contribute significantly. We have developed an integrated model of the process which assigns weights to the two mechanisms; the weighting factors are then related to the process and equipment parameters. 5 refs., 2 figs.

22969 **Fluctuating interfaces: A series of synchrotron x-ray scattering of interacting stacked membranes.** . Safinya, C.R. (Exxon Research and Engineering Co., Annandale, NJ (US)). pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

In this paper the authors concentrate on fluctuation phenomena encountered in interacting multilayered fluid membranes using synchrotron x-ray scattering as the primary tool. These systems consisting of surfactant or lipidic surfaces, are prototype models for understanding the statistical behavior of fluctuating surfaces embedded in three-dimensions. In elucidating the nature of fluid membranes they stress a unique intrinsic property: in contrast to usual surfaces with finite shear moduli, where surface tension plays a central role, the free energy of these essentially tensionless surfaces is governed by their geometrical shape and its fluctuations. They present data in a new regime of stability for very dilute and flexible membranes with interlayer separations of order hundreds of angstroms. This is in contrast to most rigid membranes where the interlayer interactions are dominated by detailed microscopic interactions such as hydration and van der Waals.

They show that the stability of these dilute lamellar phases is associated with violent out-of-plane fluctuations of the membranes giving rise to an effectively large long-range repulsive interaction. Because of its entropic origin, this interaction is universal and the authors present data for two different surfactant systems. They show that this new regime is distinct from the classical regime in which largely separated membrane sheets are stabilized because of their mutual electrostatic repulsion.

22970 **Studies of an InAs/GaAs heterojunction by total-electron-yield.** Krol, A. (Dept. of Physics, State Univ. of New York at Stony Brook, Stony Brook, NY (US)); Sher, C.J.; Storch, D.R.; Woronick, S.C.; Krebs, L.; Kao, Y.H.; Chang, L.L. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Total electron yield (TEY) of an InAs/GaAs heterojunction due to soft x-ray excitation has been studied. This heterojunction was prepared by an overgrowth of a 600 A InAs layer on a GaAs substrate using molecular beam epitaxy. In this paper, experimental data are compared with theoretical analysis based on a modified Fresnel formulation to calculate the wave field distribution in stratified media with interfacial roughness. The TEY angular profiles obtained at a given x-ray energy reveal information on the interfacial roughness, secondary electron escape length, attenuation length of elastically scattered photo-electrons, and optical constants of the epilayer in the x-ray regime.

6561 Superconductivity

Refer also to citation(s) 22171, 22172, 22333, 22877

22971 (AD-A–214681/9/XAB) **Electronically induced phase transformations. Final report, 1 October 1975-30 September 1980.** Freeman, A.J. Northwestern Univ., Evanston, IL (USA). Dept. of Physics and Astronomy. Dec 1980. 71p. Available from NTIS, PC A04/MF A01.

The electronic interactions responsible for the observed electronically induced phase transformations in several important classes of materials were investigated theoretically in close collaboration with experimental programs at other institutions. These include destruction of superconductivity and onset of a normal magnetic state at low temperatures in ternary rare-earth superconducting compounds and the possible occurrence of a new mixed phase, the origin of the phase transition to the superconducting phase in the Chevrel compounds, the possibility of excitonic superconductivity in CuCl, and the origin of phonons.

22972 (LBL–27461) **High resolution transmission electron microscopy study of defect structures in mixed-phase YBaCuO.** Fendorf, M.; Kvam, E.; Gronsky, R. Lawrence Berkeley Lab., CA (USA). Dec 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119–103: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007767. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Mixed-phase superconducting YBaCuO is characterized by means of high-resolution transmission electron microscopy. This technique reveals that such material contains numerous crystallographic defects of various types. Several of these are described in detail, and their origins discussed. 7 refs., 6 figs.

22973 (UCRL–101287) **The electronic properties of high T_c superconductors probed by positron annihilation.** Sundar, C.S. (Missouri Univ., Kansas City, MO (USA)); Bharathi, A.; Jean, Y.C.; Hinks, D.G.; Dabrowski, B.; Zheng, Y.; Mitchell, A.W.; Ho, J.C.; Howell, R.H.; Wachs, A.L. Lawrence Livermore National Lab., CA (USA). 23 Jun 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890718–34: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE90008354. Available from NTIS, PC A02/MF A01 - OSTI.

The discovery of superconductivity at 30K in $Ba_{.6}K_{.4}$ BiO_3 has generated considerable excitement in view of the contrasting properties of the Ba-K-Bi-O system when compared to the well known Cu-O based high temperature superconductors. Positron annihilation spectroscopy, which is a sensitive local probe of the electronic and defect properties of a solid, has been extensively applied in the study of Cu-O based superconductors. In the present paper, the results of positron lifetime as a function of temperature in Ba-K-Bi-O are presented and compared with the known results in the cuprate superconductors. Plausible reasons for the observed temperature dependence of positron lifetime are presented. 7 refs., 2 figs.

22974 **Polarized x-ray absorption studies of oxide superconductors.** Ercan Alp, E. (Argonne National Lab., Argonne, IL (US)); Mini, S.M.; Ramanathan, M.; Veal, B.W.; Soderholm, L.; Goodman, G.L.; Dabrowski, B.; Shenoy, G.K.; Guo, J.; Ellis, D.E. pp. 304 of Synchrotron radiation in materials research. Clark, R.; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (1989). DOE Contract W-31-109-ENG-38. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Polarized x-ray absorption studies have been carried out at the Cu K-edge to study the effect of Sr doping in La_2CuO_4 and oxygen doping in Y $Ba_2Cu_3O_6$+x. These measurements help to elucidate the transitions giving rise to the absorption edges. The authors offer an explanation of the polarization shifts of features in terms of the results of their embedded cluster calculations of electronic structure.

6570 Theoretical and Mathematical Physics

22975 (CEA-CONF–9806) **Transition to turbulence via spatiotemporal intermittency.** Chate, H.; Manneville, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). 1988. 5p. (CONF-8808294–: YKIS'88, Kyoto (Japan), 22-26 Aug 1988). Order Number DE90756434. Available from NTIS (US Sales Only), PC A02/MF A01.

The transition to turbulence via spatiotemporal intermittency for weakly confined systems is studied. Purely stochastic models, in terms of probabilistic cellular automata (as close as possible to the qualitative behaviour of the coupled map lattices), allow the development of a standard mean-field approximation. The presence of defects is considered to explain the evolution of the laminar phase. Results indicate a discontinuous transition when the connectivity is low (2 neighbors) and that the turbulent regime is hardly observable for higher neighbor number. The data interpretation is based on the usual concepts of thermodynamic phase transitions and standard statistical mechanics.

22976 (CONF-8906270–2) **The basis spline method and associated techniques.** Bottcher, C.; Strayer, M.R. Oak Ridge National Lab., TN (USA). 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989. Order Number DE90008403. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We outline the Basis Spline and Collocation methods for the solution of Partial Differential Equations. Particular attention is paid to the theory of errors, and the handling of non-self-adjoint problems which are generated by the collocation method. We discuss applications to Poisson's equation, the Dirac equation, and the calculation of bound and continuum states of atomic and nuclear systems. 12 refs., 6 figs.

22977 (GSI–89-86(prepr.)) **Fermionic molecular dynamics.** Feldmeier, H. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Dec 1989. 26p. Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

A new type of molecular dynamics is proposed to solve approximately the many-body problem of interacting identical fermions with spin 1/2. The interacting system is represented by an antisymmetrized many-body wave function consisting of single-particle

states which are localized in phase space. The equations of motion for the parameters characterizing the many-body state (e.g. positions, momenta and spin of the particles) are derived from a quantum variational principle. The proposed Fermionic Molecular Dynamics (FMD) model is illustrated with help of two examples. (orig.).

22978 (K/CSD/TM–90) **Area Over Length (AOL): A program for the calculation of effective two-dimensional thermal conductance through an arbitrarily shaped region.** Wendel, M.W. Oak Ridge Gaseous Diffusion Plant, TN (USA). Feb 1990. 31p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90008005. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A computer program, Area Over Length (AOL), has been developed to solve for the effective thermal conductance between two isothermal surfaces through a region or arbitrary shape. It is based on a boundary integral method that is derived using complex variables. It is especially useful as an aid to finite-difference and finite-element modeling of irregularly shaped regions. The theory behind AOL applies to the linear solution of any two-dimensional, steady state heat conduction problem without holes in the computational domain. However, AOL has been developed for the specific case in which the boundary consists of four pieces: two opposing isothermal pieces and two opposing adiabatic pieces. This case applies when the effective thermal conductance of a heat flow path between two nodes in a discretization of a larger domain is desired. The program requires that the user supply a boundary discretization of the region across which heat transfer occurs. Also, the points in the boundary discretization that separate the pieces of the boundary must be indicated. A sample problem is discussed. 4 refs., 10 figs.

22979 (ORNL/TM–11468) **Periodic trajectories for two-dimensional nonintegrable Hamiltonians.** Davies, K.T.R. Oak Ridge National Lab., TN (USA). Feb 1990. 75p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-900176–1: ORNL chaos workshop, Oak Ridge, TN (USA), 10-11 Jan 1990). Order Number DE90008082. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

I want to report on some calculations of classical periodic trajectories in a two-dimensional nonintegrable potential. After a brief introduction, I will present some details of the theory. The main part of this report will be devoted to showing pictures of the various families of trajectories and to discussing the topology (in E-τ space) and branching behavior of these families. Then I will demonstrate the connection between periodic trajectories and "nearby" nonperiodic trajectories, which nicely illustrates the relationship of this work to chaos. Finally, I will discuss very briefly how periodic trajectories can be used to calculate tori. 12 refs., 40 figs.

22980 (SLAC-PUB–5189) **A finite Zitterbewegung model for relativistic quantum mechanics.** Noyes, H.P. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 19 Feb 1990. 48p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900299–1: 6. annual west coast meeting of the Alternative Natural Philosophy Association, Stanford, CA (USA), 10-11 Feb 1990). Order Number DE90008031. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Starting from steps of length $\hbar/mc$ and time intervals $\hbar/mc^2$, which imply a quasi-local Zitterbewegung with velocity steps $\pm c$, we employ discrimination between bit-strings of finite length to construct a necessary 3+1 dimensional event-space for relativistic quantum mechanics. By using the combinatorial hierarchy to label the strings, we provide a successful start on constructing the coupling constants and mass ratios implied by the scheme. Agreement with experiments is surprisingly accurate. 22 refs., 1 fig.

22981 (UCID–21793) **Efficient, high order solution technique for the Liouville equation.** Sacks, R.; Shore, B.; Hermann, M.; Dixit, S. Lawrence Livermore National Lab., CA (USA). 23 Feb 1988. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008060. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In constructing a time-dependent model of the propagation of high intensity, multifrequency light through a Raman active medium, it is necessary to solve the Liouville equation for the time evolution of the density matrix. This paper discusses the high order solution technique of this equation in a constant-field-envelope case. 2 refs.

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Refer also to citation(s) 22915

22982 (CONF-8910313–3) **A search for neutrons and gamma rays associated with tritium production in deuterated metals.** Wolf, K.L.; Lawson, D.R.; Packham, N.J.C.; Wass, J.C. Texas A and M Univ., College Station, TX (USA). 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40437;FG05-86ER40256. From NSF/EPRI workshop on anomalous effects in deuterated materials; Washington, DC (USA); 16-18 Oct 1989. Order Number DE90007641. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Tritium activity has been measured in several Pd-Ni-D_2O electrolytic cells, as reported previously. At the present time 13 separate cells have shown tritium at 10^2 to 10^6 times the background level of the D_2O used in these experiments. The appearance of the activity in the electrolyte and in the gas phase occurs over a period of hours to a few days after remaining at or near the background level during 4–10 weeks of charging in 0.1 M LiOD, D_2O solution. The present paper deals with attempts to reproduce the tritium measurements and to establish the source, from either contamination or nuclear reaction. The sudden appearance of tritium activity in the cells requires the tritium to be loaded in a component prior to the beginning of cell operation in a contamination model. Release is assumed to be caused by deterioration of one of the materials used in the 0.1 M LiOD solution. In an extensive set of tests, no contamination has been found in the starting materials or in normal water blanks. Results for neutron and gamma-ray correlations have proved to be negative also. The limit set on the absence of 2.5 MeV neutrons for the t/n ration is 10^7 from that expected in the d + d reaction, and 10^3 for 14 MeV neutrons expected from the t + d secondary reaction. Similarly, Coulomb excitation gamma rays expected from the interaction of 3 MeV protons with Pd are found to be absent, which indicates that the d(d,p)t two-body reaction does not occur in the Pd electrode. 9 figs., 2 tabs.

22983 Angular-momentum limitations in heavy ion-induced fusion reactions leading to ^{40}Ca and ^{42}Ca. Harmon, B.A. Thesis (Ph. D.). 219p. Univ. of Virginia, Charlottesville, VA (US) (1987). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-01,231.

Cross sections for the fusion of ^{28}Si + ^{12}C from 4.6 to 9.4 MeV/nucleon and ^{30}Si + ^{12}C from 5.2 to 8.3 MeV/nucleon have been measured. The bombarding energy covered in these experiments extends from the intermediate to high energy regimes of the fusion excitation function where the fusion cross section is known for most heavy ion-induced reactions to be decreasing. The decrease in the high energy fusion cross section is understood to be caused by a limitation imposed on the fusing system by the maximum angular momentum (l_{cr}) the system can sustain. The mechanisms which determine the l_{cr} for a particular projectile-target combination, or entrance channel, are however, not understood. It has been found that the characteristics of the entrance channel, rather than those of the compound nuclei ^{40}Ca and ^{42}Ca, determine the l_{cr} for the ^{28}Si + ^{12}C and ^{30}Si + ^{12}C systems, respectively. The experiments were carried out with the time of flight apparatus at the Holifield Heavy Ion Research Facility at Oak Ridge National Laboratory. Beams of ^{28}Si and ^{30}Si ions were used to bombard ^{12}C targets and complete or partial angular distributions for the heavy reaction products with atomic numbers from 24 to 40 were obtained at 6.4, 7.8, and 9.4 MeV/nucleon for ^{28}Si + ^{12}C and 5.2, 5.7, 6.4, 7.5, and 8.3 MeV/nucleon for ^{30}Si + ^{12}C. Charge and mass identification, combined with a kinematic analysis of the velocity distributions for individual isotopes, allowed separation of the yields from compound nucleus evaporation residues and nonfusion processes.

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Refer also to citation(s) 21915, 22354, 22363, 22364, 22373, 22983, 23115, 23116, 23126, 23135, 23139, 23148, 23149, 23151, 23162, 23163, 23167, 23169, 23172, 23179, 23182, 23183, 23184, 23185, 23186, 23187, 23191, 23192, 23211, 23238

22984 (CEA-CONF–9533) **Stimulated Raman scattering and ion dynamics: the role of Langmuir wave non-linearities.** Bonnaud, G.; Pesme, D. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1987. 25p. (CONF-8711338–: 8. workshop on laser interaction and related plasma, San Diego, CA (USA), 2-6 Nov 1987). Order Number DE90756448. Available from NTIS (US Sales Only), PC A03/MF A01.

The saturation of the Stimulated Raman Scattering (SRS) is studied by means of wave-coupling numerical simulations. A new code (CHEOPS) has been designed in order to model these couplings, in real 1-D space, with aperiodic boundary conditions. Each wave can be represented either by a complete amplitude or by an envelope amplitude only. The choice of the wave set to be coupled allows to investigate separately some mechanisms relevant in long time SRS evolution. The various mechanisms which may inhibit SRS growth are reviewed and the SRS saturation scenarios are exhibited in an homogeneous density plasma slab. The ion dependent mechanisms appear to be the most efficient ones to saturate SRS. Their importance is strongly bound to the electron temperature and to the ion fluctuation level at time when SRS has already grown many e-foldings.

22985 (CEA-CONF–9534) **Density and temperature diagnostics of a Ne-like germanium plasma created by laser.** Berthier, E.; Bourgade, J.L.; Combis, P.; Jacquemot, S.; Le Breton, J.P.; Louis-Jacquet, M.; Naccache, D.; Nail, M.; Peyrusse, O. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1987. 4p. (CONF-8709143–:). Order Number DE90756449. Available from NTIS (US Sales Only), PC A02/MF A01.

In the framework of X-ray laser studies, experiments on Ne-like Ge plasma have been performed by laser irradiation at $\lambda = 1.053$ μm. Amplification in lasing transitions has been observed by varying the plasma length. Theoretical calculations of excited level population allow us to determine density and temperature from line intensity ratios.

22986 (CEA-CONF–9535) **High resolution soft X-Ray spectrometer with 5-picosecond time-resolution for laser-produced plasma diagnostics.** Mexmain, J.M. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (FR)); Bourgade, J.L.; Louis-Jacquet, M.; Mascureau, J. de; Sauneuf, R.; Schwob, J.L. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1987. 5p. (CONF-8709143–:). Order Number DE90756403. Available from NTIS (US Sales Only), PC A02/MF A01.

A new XUV spectrometer designed to have a time-resolution of 3 ps and a spectral resolution of 0.1 A is described. It is basically a modified version of a Schwob-Fraenkel spectrometer, which is coupled to a new ultrafast electronic streak camera.

22987 (CONF-900174–1-Vugraphs) **High elongation plasmas.** Lazarus, E.A. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From CIT West Coast physics meeting; San Diego, CA (USA); 29 Jan 1990. Order Number DE90007575. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper contains viewgraphs on axisymmetric stability of doublet-3 tokamak. The information available on this stability is applied to the Compact Ignition Tokamak. (LSP)

22988 (CONF-900288–4) **Difference in electron thermal diffusivity and profile between interior and exterior of TFTR L-mode plasmas.** Hiroe, S. (Oak Ridge National Lab., TN (USA)); Johnson, D.W.; Goldston, R.J. Oak Ridge National Lab., TN (USA). [1990]. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 2. transport task force workshop; Hilton Head, SC (USA); 19-23 Feb 1990. Order Number DE90007479. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The local properties such as scale lengths of the electron density (L_{n_e}), temperature (L_{T_e}), and pressure (L_{p_e}), and the electron thermal diffusivity $\chi_e(r)$ (m^2/s) for $r/a > 0.3$ have been studied for TFTR L-mode discharges under the assumption of $\chi_e = \chi_i$. The scale lengths and the electron thermal diffusivity in the interior $0.3 < r/a < 0.55$ are significantly different from those on the exterior $0.55 < r/a < 0.8$. following are some examples (temperatures in keV, other quantities in MKS units). In the interior ($0.3 < r/a < 0.55$), most of the scale lengths were constant or a weakly dependent on radius, and χ_e can be expressed as (with correlation coefficient R = 0.61), $\chi_e(r) = 1.44 \times 10^{18}(r/a)^{1.0}T_e(r)^{0.1}q(r)^{0.1}/n_e^{0.9}(r)$. In the exterior region ($0.55 < r/a < 0.8$), the scale lengths decrease monotonically, and χ_e can be described as (with R = 0.68), $\chi_e(r) = 2.3 \times 10^3(r/a)^{1.7}T_e(r)^{0.7}q(r)^{0.8}/n_e^{0.2}(r)$. It is interesting to note the negative n_e dependence of χ_e in the interior and the positive T_e dependence of χ_e in the exterior.

22989 (DOE/ET/51013–276) **CIT burn control using auxiliary power modulation.** Chaniotakis, E.A.; Freidberg, J.P.; Cohn, D.R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. 29 Sep 1989. 72p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-78ET51013. (PFC/RR–89-16). Order Number DE90007640. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

It is predicted that ignited tokamaks such as CIT will experience a thermal instability. In this work a zero dimensional transport model is used as a means of examining this thermal instability. In order to solve the problems associated with the uncertainty in predicting the behavior of an ignited tokamak plasma, auxiliary power may be used for mapping the tokamak operating space, both in the low temperature stable regime and in the high temperature unstable regime. Auxiliary power modulation as a means of burn control is the most reliable method, especially during the initial stages of CIT operation. By modulating the auxiliary power stable thermal equilibria can be created at relatively high values of Q (~65). 20 refs., 28 figs.

22990 (DOE/ET/51013–278) **Measurements on injected impurity transport in TEXT [Texas Experimental Tokamak] using multiply filtered soft x-ray detectors.** Wenzel, K.W. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. Jan 1990. 234p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-78ET51013. (PFC/RR–90-1). Order Number DE90007638. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

Aluminum was injected into TEXT to study trace, non-recycling impurity transport. A 92-channel, three array x-ray imaging system was constructed and installed to measure temporally-resolved density profiles of the three highest charge states. A novel krypton filter in one array discriminated between the He-like and H-like resonance lines, and a hard filter responded mostly to the fully stripped charge state. The impurity confinement time scaled approximately as $\tau_c \sim \bar{n}_e Z_{eff}\sqrt{m_i}/Z_i I_p$ (i denotes the background gas). Aluminum density profiles averaged over a sawtooth crashes were also measured for a few discharges. Sawteeth strongly enhanced the inward impurity flow immediately following injection, when the density was still peaked near the plasma edge. Those discharges with the longest sawtooth period obtained the most peaked aluminum density profiles; thus sawteeth were also important in ameliorating impurity accumulation on the tokamak axis. The charge state balance of the aluminum ions obtained from the measured profiles was compared to predictions of coronal equilibrium. Somewhat surprisingly the aluminum ions were close to coronal, except in those discharges with very short sawtooth periods or very large inversion radii. Preliminary evidence of up-down asymmetric density profiles was also found. Numerical simulations of aluminum transport were performed. The effect of sawtooth oscillations was taken into account with a simple flattening model. The data disagreed with a constant D anomalous model except in the plasma center; enhanced outward transport was required. The experiments did not agree with neoclassical simulations, because the theory had outward convection that was too large. 237 refs., 86 figs., 8 tabs.

22991 (DOE/ET/51013–279) **TSC [Tokamak Simulation Code] simulations of Alcator C-MOD discharges II: Single**

X-point, vertically asymmetric scenario. Ramos, J.J. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. Jan 1990. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-78ET51013. (PFC/RR–90-2). Order Number DE90007639. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A simulation of a single X-point diverted discharge of the Alcator C-MOD tokamak is carried out using the Tokamak Simulation Code (TSC). 2 refs., 31 figs., 1 tab.

22992 (EUR-CEA-FC–1345) **A conceptual steady-state tokamak reactor with passive current generation.** Johner, J.; Fidone, I. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1988. 36p. Available from NTIS (US Sales Only), PC A03/MF A01.

Current generation in a tokamak reactor using synchrotron radiation and the bootstrap effect is considered. It is found that for sufficiently high temperatures, the total current generated by these passive drivers is sufficient to allow continuous operation with parameters satisfying the density and beta limitations as well as the thermal balance requirements.

22993 (EUR-CEA-FC–1355) **Variational calculation of electromagnetic instabilities in tokamaks.** Garbet, X.; Laurent, L.; Mourgues, F.; Roubin, J.P.; Samain, A. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. Aug 1988. 32p. Available from NTIS (US Sales Only), PC A03/MF A01.

A variational method is presented in order to determine and study linear microinstabilities in tokamaks. Exploiting the existence of a system of action and angular variables for trapped and circulating particles, a functional, extremum in the turbulent electromagnetic field, is analytically established and implemented in the code TORRID. The coupling of poloidal harmonics due to toroidal effects is investigated within the frame of a WKB formalism whose zeroth order is equivalent to the ballooning analysis. The essential features of the code TORRID are described. Curvature effects on ionic modes profiles and stability thresholds are presented as an example of application.

22994 (EUR-CEA-FC–1360) **Dynamical systems in plasma theory.** Maschke, E.K. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. Nov 1988. 15p. Available from NTIS (US Sales Only), PC A03/MF A01.

After a short introduction into the theoretical description of magnetically confined plasmas, typical dynamical systems describing plasma phenomena are discussed.

22995 (EUR-CEA-FC–1365) **Turbulence associated with the sawtooth internal disruption.** Andreoletti, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France)—Dept. de Recherches sur la Fusion Controlee (France)); Laviron, C.; Olivain, J.; Pecquet, A.L.; Gervais, F.; Gresillon, D.; Hennequin, PAssociation Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 41p. Available from NTIS (US Sales Only), PC A03/MF A01.

Specific turbulence associated with the sawtooth internal disruption has been observed on TFR tokamak plasmas by analyzing density fluctuations with CO_2 laser light scattering. The time localization is clearly connected with the successive phases of the relaxation process. Some specific turbulence appears in relation to the kink motion, but the main burst corresponds to the collapse phase. We concentrate our study on this strong burst and show first its frequency and wave number spectral properties and the corresponding pseudo dispersion relation. The specific turbulence is spatially localized. It is within the interior of the q = 1 surface and extends approximately 120^0 azimuthally. Taking into account the twisting of the central plasma during the turbulent kink phase, this location agrees with the azimuthal position of the "sooner and faster" outgoing heat flux. The power level of this turbulence is two orders of magnitude larger than the local quasi-stationary turbulence. These observations are in fair agreement with the predictions of the sawtooth disruption model previously proposed by Andreoletti. The observed specific turbulence shows several similarities with the so called "magnetodrift turbulence" described in the model.

22996 (FRCEA-TH–169) **Interaction of a beam of heavy ions with a CO_2 laser produced plasma. Fitting of an ionographic tube and simulation of the experiment.** Guihaume, J.M. Paris-11 Univ., 91 - Orsay (France); CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France). 1986. 192p. (In French). Order Number DE90756433. Available from NTIS (US Sales Only), PC A09/MF A01.

The experimental device and methods, applied in the obtention of the first experimental results from the interaction between a heavy ions beam and a plasma, are described. The charge, energy and spatial distributions of the burst of heavy ions, after its passage the coronal plasma, are obtained. The burst of heavy ions is produced by means of a 7 MV tandem accelerator, and the plasma is obtained by means of two CO_2 laser beams: (1) the charge distribution of the burst of ions, coming out of the plasma, is a Gaussian function; (2) the mean charge of the burst of ions, coming out of the plasma, increases with the ionization state and the electron density of the plasma, as well as with the energy of the incident ions; (3) the energy loss becomes important for unidirectional electron densities higher than 5.10^{-18} cm^{-2}.

22997 (FRNC-TH–3348) **Study and development of different techniques for the generation, conversion, propagation, and radiation of high power microwaves for the electronic cyclotron frequency plasma heating.** Rebuffi, L. Paris-11 Univ., 91 - Orsay (France); Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee. Oct 1987. 124p. (In French). Order Number DE90756363. Available from NTIS (US Sales Only), PC A06/MF A01.

The development and optimization of a microwave technique, concerning the high frequency (electronic cyclotron frequency) plasma heating is presented. The experiments are effectuated on the Fontenay-aux-Roses TFR tokamak, with 660 kw whole power, during 100 msec, produced at 60 GHz. Low power tests are performed on the different transmission line components (there are 3, formed by metallic circular waveguides). The work also includes: the development of a lens formed by thin metallic plans; the study of slotted surface mirror; the development of a system for the accurate measurement (5.10^{-6}) of the gyrotronic frequency; a theory, based on the equivalent circuits method, generalized to the rotational and polarization mirrors; the development of a numerical simulation code. A practical scheme, for the optimization of the parameters concerning the optical transmission line project, is given. The results of this work can be applied to the experiment involving power levels, frequencies and times of impulsion increasingly higher (respectively about MW, 100 GHz and 10s) than the reported ones. Moreover, they can also be used in any experiment in the microwave field.

22998 (IAEA-TECDOC–536) **Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 173p. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This summary report on the Technical Committee Meeting organized by the IAEA and held in Naka-Gun, Japan, 13-15 February 1989, provides an overview of the results presented. Of the twenty-three papers presented, sixteen were devoted to tokamak experiments. These presented data of plasma behavior in the scrape-off layer and divertor regions, as well as effects of impurities on the core plasma; these are summarized here. Other papers summarized deal with plasma-wall interactions, including wall material behavior. Still others deal with theoretical work on physics modelling in the edge region. Refs, figs and tabs.

22999 (IAEA-TECDOC–536, pp. 23-29) **Edge phenomena of JFT-2M plasma.** Ohtsuka, H. (Japan Atomic Energy Research

Inst., Tokai, Ibaraki (Japan). Dept. of Thermonuclear Fusion Research). JFT-2M Group. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

During these several years we have been looking for dc-type ExB convection to which we can attribute a cause of anomalous transport in the tokamak edge region. We report here the present status of the research. First, we show limiter induced convection. We observed that in the plasma-limiter contact area there occurs convection of the plasma in the radial direction. The mechanism that induce such convection is discussed. Second, we show that fast wave (FW) injection modifies density pattern in the edge. From the dependence on the magnetic field, we draw a mechanism that is responsible for the production of such a flow pattern. Last, we present plasma response in the scrape-off layer to ICH injection. Floating potential measurement shows it is very probable that ICH injection also produces convection in the scrape-off-layer. From these observations we draw conclusions putting an emphasis on localized disturbance in the plasma. (author). 7 figs, 1 tab.

23000 (IAEA-TECDOC–536, pp. 31-36) **Current drive and particle control by divertor biasing.** Shimada, M. (Japan Atomic Energy Research Inst. (Japan)); Stambauch, R.D.; Mahdavi, M.A.; Schaffer, M.; Staebler, G.; Hinton, F. International Atomic Energy Agency, Vienna (Austria). Jan 1990. Contract DE-AC03-84ER51044. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Uncontrollable density build-up and impurity accumulation are major problems of ELM-free H-mode discharges. Here we discuss a possibility of particle control by divertor bias. The idea is to electrically insulate divertor plates and apply voltage between the divertor plates on inside and those on outside. Current in the scrape-off layer flows along the field line, which provides a simple non-inductive current drive. The resistive drop will create poloidal electric field, which induce outward particle flux when scrape-off layer current is in the direction of the plasma current. (author). 5 refs, 5 figs, 1 tab.

23001 (IAEA-TECDOC–536, pp. 37-42) **Impurity production and recycling in JET.** De Kock, L. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Bures, M.; Clement, S. JET Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Scrape-off plasma parameters in RF heated JET discharges are reported. At very high additional heating power it is observed that a strongly increased carbon influx can occur leading to a sharp decrease of the measured DD neutron reaction rate. This paper describes also the progress made in studying wall pumping and recycling. (author). 13 refs, 7 figs.

23002 (IAEA-TECDOC–536, pp. 43-48) **Scaling study of scrape-off layer and divertor plasmas.** Itoh, S.I. (Hiroshima Univ. (Japan). Inst. for Fusion Theory); Ueda, N.; Itoh, K. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

2D time dependent transfer code UEDA has been applied to the single-null divertor plasma in JFT-2M tokamak in order to study the transport of scrape-off layer plasma. The parameter dependencies of the edge density temperature as well as the temporal evolution and transient response was evaluated. From the point of view of an impurity source from the divertor plate, the discovered transient peak on the ion temperature could play a sufficient role in the transport phenomena. (author). 16 refs, 4 figs.

23003 (IAEA-TECDOC–536, pp. 61-66) **Impurity transport at arbitrary concentration in the divertor plasma.** Igitkhanov, Yu.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii). International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This paper describes a new model for impurity transport in the scrape-off plasma layer. It has shown that under the condition of high impurity concentration they could play an important role in the transport phenomena. The impurity ions of an arbitrary concentration was taken into account and the main results of the analysis could be formulated in the following ways: (1) outside the recycling zone near the divertor plate the ion thermal force plays a decisive and unfavourable role in the distribution of highly-ionized impurities, (2) in the recycling region the favourable drag force is stronger than the thermal force and provides a good divertor retention. (author). 5 refs, 2 figs.

23004 (IAEA-TECDOC–536, pp. 55-60) **First wall and divertor plate sputtering in a tokamak reactor.** Abramov, V.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Igitkhanov, Yu.L.; Pistunovich, V.I.; Pozharov, V.A. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The paper contains results of theoretical analyses of erosion of first wall and divertor plates for plasma facing components in a future tokamak-reactor. The calculations have been performed under the conditions of sufficient energy distribution function distortions and the angular dependence of the sputtering yield taken into account. The obtained data show that the distribution function distortion leads to the sputtering yield increases by a factor of 2 which is comparable with one due to the angular effect. (author). 3 refs, 1 fig., 2 tabs.

23005 (IAEA-TECDOC–536, pp. 67-73) **Heat flow to the divertor plates in JT-60 lower X-point discharges.** Itami, K. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Nishitani, T.; Hosogane, N.; Matoba, T. JT-60 Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Strong asymmetry in recycling and heat load between the inner leg and the outer leg of the separatrix in JT-60 tokamak is observed. When the toroidal field is reversed, the asymmetry is also reversed. An improved divertor confinement is obtained with high power neutral beams which is associated with the reduction of the radiation in the core plasma and the increase of recycling and radiation in the divertor region. (author). 2 refs, 9 figs.

23006 (IAEA-TECDOC–536, pp. 89-94) **Measurements of the charge state distribution and transport of iron impurity ions in TFTR plasmas by a multi-chord X-ray crystal spectrometer.** Bitter, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Hsuan, H.; Hill, K.W.; Hulse, R.A.; Von Goeler, S.; Johnson, D.; Grek, B. International Atomic Energy Agency, Vienna (Austria). Jan 1990.

Contract DE-AC02-76-CHO-3073. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The radial charge-state distribution and transport of iron impurity ions in ohmically heated TFTR plasmas has been determined by a detailed comparison of the X-ray spectra obtained from a high resolution multi-chord crystal spectrometer with the predictions from plasma modeling calculations. (author). 9 refs, 3 figs, 1 tab.

23007 (IAEA-TECDOC–536, pp. 95-100) **Impurity behaviour during ECH in the Texas experimental tokamak.** Rowan, W.L. (Texas Univ., Austin, TX (USA). Fusion Research Center); Bravenec, R.V.; Austin, M.E. International Atomic Energy Agency, Vienna (Austria). Jan 1990. Grant DE-FG05-88ER53267;Grant DE-FG05-88ER53266. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

During electron cyclotron heating in the Texas Experimental Tokamak, the concentration of metallic impurities near the plasma center increased. In the experiment, a 60 GHz predominantly 0-mode wave was launched from the low-field side of the tokamak plasma. Approximately 100 kW (equivalent to 1/3 of the OH power) was deposited within a few centimeters of the plasma major radius. From analysis of the impurity behavior, it appears that the ECH induced both a substantial increase in the edge impurity source and a modest reduction in the inward impurity transport. Specifically, the edge source was increased by as much as 40%, while for $p>0.7$, the impurity diffusion was increased by 50%. The enhanced impurity diffusion occurs simultaneously with a reduction in particle confinement and with an increase in plasma potential. (author). 3 refs, 4 figs.

23008 (IAEA-TECDOC–536, pp. 101-106) **Impurity behavior in PBX L- and H-mode plasmas.** Ida, K. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Fonck, R.J.; Sesnic, S.; Hulse, R.A.; Leblanc, B.; Paul, S.F. International Atomic Energy Agency, Vienna (Austria). Jan 1990. Contract DE-AC02-76-CHO3073. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Intrinsic impurity behavior and transport properties in neutral beam heated L- and H- mode PBX tokamak plasmas has been studied with a variety of impurity diagnostics. Central impurity accumulation is most often observed in H-mode discharges and sometimes results in a thermal collapse (rapid decrease of both ion and electron temperature) due to high central metallic radiation ($\approx$1.5 Wcm^{-3}). The accumulation is evident from peaked Z_{eff} and radiated power profiles and further substantiated from specific VUV and X-ray spectroscopy measurements. It is shown that impurity accumulation is neither unique to or inevitable in H-mode discharges, and it can be suppressed by sufficient gas puffing. Central accumulation is also seen in L-mode plasmas even with co-injected neutral beams. This usually occurs at high beam power and relatively low density. While there is no difference in the degree of accumulation between L- and H-mode discharges, the Z_{eff} profile itself is more peaked in the H-mode due to flatter electron density profiles in H-mode plasmas than L-mode plasmas. The degree of accumulation increases as Z_{eff} itself increases and is qualitatively explained by neoclassical convection and diffusion flux terms driven impurity-impurity collisions in addition to the usual impurity-plasma ion contributions. (author). 5 figs.

23009 (IAEA-TECDOC–536, pp. 115-121) **Impurity problems related to ICRF heating on the JIPP T-IIU tokamak.** Ogawa, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). JIPP T-IIU Group. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

In the JIPP T-IIU tokamak, a high power ICRF heating experiment has been conducted up to an extremely high power density ($\approx$ 2MW/m^3) with the total rf power of P_{rf}=2MW. Much attention has been paid to an impurity problem, and it has been found that (a) the adoption of low-Z materials as the limiter, (b) in situ carbon coating (i.e., carbonization) and (c) the adequate gas-puffing synchronized to the rf pulse are very effective to suppress the radiation loss. In combination with these methods, a remarkable reduction of the metal impurity (especially an iron) has been achieved, suppressing the total radiation loss less than 30$\approx$40% of the input power. Our five-element antenna system can provide an elaborate $k_{parallel}$-tailoring. It is found that the effect of $k_{parallel}$-tailoring on the impurity problem is unexpectedly small. (author). 5 refs, 8 figs.

23010 (IAEA-TECDOC–536, pp. 131-138) **Divertor effects and confinement properties of JT-60 lower X-point divertor discharges.** Hosogane, N. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Tsuji, S.; Kubo, T.; Sugie, T.; Nishitani, T.; Itami, K.; Naito, O.; Nagami, M. JT-60 Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

An improved divertor confinement (IDC) regime, which is characterized by a confinement improvement and remote radiative cooling, has been obtained in NB heated lower X-point divertor discharges in JT-60. The IDC regime has a threshold in heating power (10 MW) and a threshold in electron density. The threshold electron density depends on the connection length between the main plasma and the divertor plates. The remote radiative cooling is large for discharges with high toroidal magnetic field. The improvement in energy confinement is compatible with the remote cooling as large as 50% of the input power. (author). 5 refs, 7 figs.

23011 (IAEA-TECDOC–536, pp. 139-144) **Behavior of light impurity in beam heated JT-60 plasmas with graphite walls.** Kubo, H. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Sugie, T.; Nishino, N. JT-60 Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

In JT-60 discharges with graphite walls, it was observed that the oxygen density decreased and the carbon density increased during neutral beam heating. This phenomenon appeared in lower X-point discharges and limiter ones with neutral beam heating of high power (>12MW). There was a threshold electron density with respect to the onset of the phenomenon. In the X-point discharges, an improvement of the energy confinement (Improved Divertor Confinement) was observed with the phenomenon. (author). 7 refs, 7 figs.

23012 (IAEA-TECDOC–536, pp. 145-151) **Radiation losses and global power balance of JT-60 plasmas.** Nishitani, T. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Itami, K.; Nagashima, K.; Tsuji, S.; Hosogane, N.; Shimada, M.; Yoshida, H.; Ando, T. JT-60 Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Radiation losses and global power balances of the plasmas in the NB heated limiter, outer and lower X-point configurations with TiC coated Molybdenum or graphite first wall have been investigated by bolometric measurements, thermocouples and IRTV camera. Very low radiation losses of the main plasma, 10% of the absorbed power, are realized in NB heated outer X-point discharges with TiC coated molybdenum wall. In the improved divertor confinement (IDC) regime radiation loss from the divertor region increases up to 40% of the absorbed power with the line averaged electron density. That of the main plasma is approximately 20% for any electron density. Intense remote radiative cooling is realized in IDC which reduces the heat load onto divertor plates. (author). 7 refs, 11 figs.

23013 (IAEA-TECDOC–536, pp. 159-164) **Plasma transport in ergodized magnetic fields.** Fuchs, G. (Association Euratom-Kernforschungsanlage Juelich (Germany, F.R.). Inst. fuer Plasmaphysik); Reiter, D.; Steffen, B. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

A numerical model is presented, allowing to solve the diffusion equation for a plasma in an ergodized magnetic field. This model is applied to explain the island like structures observed from the H_α glow in the scrape-off region of TEXTOR. In accordance with the experiment, island like structures are found and they persist even in cases where the magnetic topology of the boundary - according to fieldline tracing calculations - becomes ergodic. (author). 11 refs, 4 figs.

23014 (IAEA-TECDOC–536, pp. 165-170) **Divertor plasma study in JFT-2M H-mode discharges.** Shoji, T. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan)); Nakazawa, I. JFT-2M Group. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The behaviours of the peripheral electron temperature and the divertor plasma during the H-mode in JFT-2M single-null open divertor configuration are studied. The gradient of the peripheral electron temperature at the H-mode phase is 140-200eV/cm which is steeper than that (70-100eV/cm) at the L-mode phase and is in good agreement with that predicted by Itoh's L-H transition theory. The width of half maximum of heat flux to divertor plates is about 5cm. The heat flux to the electron side divertor is larger that that to the ion side divertor and so the electron temperature or the electron side is higher than that of the ion side. On the contrary, the particle flux and the electron density of the electron side are lower than those of the ion side. The divertor plasma density (temperature) increases (decreases) with main plasma density and saturates at some value and also increases (does not change) with the input power. (author). 10 refs, 7 figs.

23015 (IAEA-TECDOC–536, pp. 171) **Impurity ion transport studies in the JET and DITE tokamaks.** Peacock, N.J. (UKAEA Culham Lab., Abingdon (UK)). International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Published in summary form.

23016 (IAEA-TECDOC–536, pp. 107-114) **Impurity transport during H-mode phase in JFT-2M.** Ogawa, H. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Dept. of Thermonuclear Fusion Research); Kasai, S. JFT-2M Group. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Impurity transport during the H-mode phase in JFT-2M was studied by using the spectroscopic measurement. In the quiescent H-mode (H-mode without ELM's) phase, both metal (titanium and iron) and light (carbon) impurity ions were accumulated in the plasma due to the enhanced particle confinement. From the comparison between the deuterium discharges and the hydrogen discharges, the impurity ions' accumulation was less pronounced in the hydrogen discharges due to the difference of the enhancement of the particle confinement in both discharges. In the H-mode with ELM's, impurity ions' accumulation was less pronounced compared with those in the quiescent H-mode phase. This is due to the exhaustion of the impurity ions by the ELM's. In the improved L-mode phase, impurity ion density profile became centrally-peaked which was concerned with the sawtooth oscillation. (author). 3 refs, 8 figs.

23017 (IAEA-TECDOC–536, pp. 123-130) **Impurity characteristics in JT-60.** Sugie, T. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kubo, H.; Sakasai, A. JT-60 Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Impurity concentrations and Z_{eff} values have been investigated in the plasmas with TiC-coated molybdenum walls and with graphite ones. Z_{eff} values and light impurity, oxygen and carbon, concentrations of the plasmas with TiC-coated molybdenum walls were lower than those with graphite ones. In the outer X-point NB heated plasmas, the Z_{eff} value was 1.6 on the TiC-coated molybdenum walls and 2.2 on the graphite ones at the line averaged electron density n-bar$_e$ of $4 \times 10^{19} m^{-3}$. And, titanium concentrations were so low that it had almost no influence on the Z_{eff} values. (author). 5 refs, 9 figs, 1 tab.

23018 (INIS-mf–11549) **Experiments on screw-pinch plasmas with elongated cross section.** Lassing, H.W. Rijksuniversiteit Utrecht (Netherlands). 16 Jun 1989. 153p. Order Number DE90706041. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

In this thesis experiments are described carried out with SPICA II, a toroidal screw-pinch plasma device, this device is the last one in a series of plasma machines of the toroidal screw-pinch differing from its predecessor in its race-track shaped section. In devices of the type toroidal screw-pinch stable confinement is possible of plasmas with larger β values than in a tokamak discharge. In a pinch the plasma is screwed up, during the formation, in such a way that in a relatively small volume a plasma is formated with a high pressure. During the screwing up the plasma is heated by shock heating as well as adiabatic compression. With the modified snowplow model the density and temperature after the formation can be calculated, starting from the initial conditions. When all ions arrive into the plasma column, the density in the column is determined by the volume compression. First purpose of the experiments was to find a stable discharge. Subsequently discharges have been made with a high as possible β in order to investigate at which maximum β it is possible to confine screw-pinch plasmas stably. When these had been found, the nature and importance could be investigated of the processes following which the screw-pinch plasma looses its energy. 75 refs., 95 figs., 8 tabs.

23019 (INIS-SU–157/A) **Gas dynamic theory of flight of fast electron flux in plasma.** Mel'nik, V.N. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Radioastronomicheskij Inst. 1988. 25p. (In Russian). Order Number DE90618767. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Preprint no.20.

The one-dimensional flight of a fast electron flux in plasma is investigated taking into account generation and absorption of plasma waves. The transition from the kinetic description to the gas dynamics is made. The closed set of gas dynamic equations for electrons and plasmons is derived and an automodel solution is

obtained in the case of instantaneous injection. This solution represents the beam-plasma formation which travels with constant velocity. The problem on natural oscillations in the system electrons+plasmons is considered. 8 refs.; 6 figs.

23020 (IPP–1/251) **Plasma angular momentum loss by MHD mode locking.** Zohm, H.; Kallenbach, A.; Bruhns, H.; Fussmann, G.; Klueber, O. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Dec 1989. 13p. Order Number DE90759507. Available from NTIS (US Sales Only), PC A03/MF A01.

The loss of angular momentum of a rotating plasma due to mode locking is investigated using spectroscopic rotation measurements and magnetic probe data. The electromagnetic force on the plasma regarding both the interaction with the resistive vessel wall and the error field is calculated. Simulations of the temporal evolution of the toroidal bulk rotation by solving the momentum transport equation in the presence of the magnetic forces explain the toroidal momentum balance in detail. As a result we find that the plasma within the island is affected by the electromagnetic force, while the rest of the plasma is slowed down by viscous coupling. (orig.).

23021 (IPP–2/299) **On the generating function of Poincare plots defining one dimensional perturbed Hamiltonian systems.** Montvai, A. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jan 1989. 35p. Order Number DE90759699. Available from NTIS (US Sales Only), PC A03/MF A01.

A simple numerical method has been devised, for deriving the generating function of an arbitrary, one dimensional Hamiltonian system represented by its Poincare plot. In this case, the plot to be numerically processed is an area preserving transformation of a two-dimensional surface onto itself. Although the method in its present form is capable of treating only this case, there are no principal restrictions excluding the analysis of systems with higher dimensionality as well. As an example, the generating function of the motion of alpha particles in a nonsymmetric, toroidal magnetic field is derived and studied numerically. (orig.).

23022 (IPP–2/302) **Proceedings of the 3rd workshop on Wendelstein VII-X.** Rau, F. (ed.). Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. 212p. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

This report presents the major part of the information given at the 3rd Workshop on Wendelstein VII-X, held at Schloss Ringberg near Lake Tegernsee, 26-30 June 1989. A number of 9 papers by members of the INTERATOM study group has been summarized. The ongoing work of the development of W VII-X is concentrated on a small number of Helias configurations with five field periods, in order to define their coil systems and the attainable parameter range. This effort aims at a simultaneous realization of the desired numbers of plasma aspect ratio, stability-β, transport, improvement in bootstrap current, etc., in order to arrive at a 'reference configuration' for this experiment. (orig.).

23023 (IPP–2/302, pp. 3-7) **Overview on Wendelstein VII-X.** Wobig, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

At IPP Garching, the experiment Wendelstein VII-X is being developed. The goals of this experiment are to continue the development of the modular advanced stellarator, to demonstrate the reactor capability of this stellarator line, and to achieve quasi-steady-state operation in a temperature regime above 5 keV. This temperature regime can be reached in Wendelstein VII-X if neoclassical transport plus the anomalous transport found in Wendelstein VII-A prevails. A heating power of 20 MW will be applied to reach the reactor-relevant parameter regime. A Helias configuration (Helical Advanced Stellarator) has been chosen because of its confinement and stability properties. (orig./AH).

23024 (IPP–2/302, pp. 8-14) **Optimization of Helias for W VII-X.** Lotz, W.; Merkel, P.; Nuehrenberg, J.; Schlueter, A.; Zille, R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Optimization of Helias equilibria at finite-β was attempted with respect to the following set of criteria: 1. high quality of vacuum field magnetic surfaces, 2. good finite-β equilibrium properties, 3. good MHD stability properties, 4. small neoclassical transport in the $1/\nu$-regime, 5. small bootstrap current in the lmfp-regime, 6. good collisionless α-particle containment, 7. good modular coil feasibility. (orig./AH).

23025 (IPP–2/302, pp. 15-23) **Non-local MHD-mode analysis of Helias equilibria.** Schwab, C. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

A formulation of the ideal MHD energy principle in magnetic coordinates yields the basis for a computational analysis of non-local modes in 3D-stellarator equilibria which involves two components of the displacement vector (code version CAS3D2), the third component being used for the imcompressibility conditions. Equilibrium calculations are performed with a 3D-code which exploits the assumption of nested magnetic surfaces (here, VMEC); the results can readily be used to construct the input data for the stability code in magnetic coordinates. A combination of two techniques, i.e. Fourier expansion in the angle-like coordinates and a simple finite element method in the radial direction, is used to set up the matrix which corresponds to the energy functional. A negative lowest eigenvalue, computed from a suitable matrix eigenvalue problem, indicates an unstable equilibrium. (orig./AH).

23026 (IPP–2/302, pp. 24-28) **Resistive ballooning modes in stellarators.** Wobig, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The resistive ballooning mode in general stellarator geometry is analyzed following the theory of D. Correa-Restrepo published in Z.f. Naturforsch. 37a, 848 (1982). The two coupled differential equations with s along the field line as independent variable can be simplified by taking the limit $\gamma_H=c_p/c_v\to 0$. (Neglect of sound waves). The remaining equation yields the equation of ideal ballooning modes if $S_M\to\infty$, where S_M is the magnetic Reynolds number. It can be shown that an unstable solution exists at any β if S_M is finite and if a finite region of unfavourable curvature exists. For Helias configurations (low shear, low geodesic curvature) a model equation of the Mathieu type can be derived, which leads to a cubic dispersion relation for the growth rate. In the limit $S_M\to\infty$ the critical beta of ideal ballooning modes can be recovered. It can be shown that sound waves ($\gamma_H\beta\neq 0$) tend to stabilize resistive ballooning modes. (orig./AH).

23027 (IPP–2/302, pp. 29-30) **Resistive ballooning modes in a Helias configuration.** Geiger, J.; Zehrfeld, H.P. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The Garching resistive ballooning code GARBO which was developed for stability analyzes of axisymmetric plasmas is about to include the treatment of three-dimensional equilibria as well. Preliminary results are presented for a sample configuration of HELIAS. Although this model does not represent a consistent finite-pressure stellarator equilibrium configuration, its general features as magnetic surface geometry and field line curvature properties are expected to reflect the reality of HELIAS. Real

growth rates are calculated in a beta range from one to five percent with the magnetic Reynolds number as parameters. The stabilizing effect of shear is demonstrated. (orig.).

23028 (IPP–2/302, pp. 31-39) **Monte Carlo calculations for Helias configurations.** Lotz, W. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Transport coefficients obtained with monoenergetic particles (using pitch angle scattering and energy relaxation) have been convoluted with a Maxwellian particle distribution. Transport coefficients with Maxwellian particle distributions are shown for the configuration Helias 50 B 5 (β=4.9%). Particle transport coefficients as well as energy transport coefficients for this configuration have been computed for ions (deuterons) as well as for electrons. From these, estimates of confinement times have been derived. (orig.).

23029 (IPP–2/302, pp. 40-46) **Ripple transport in a modular Helias.** Beidler, C.D. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Neoclassical transport rates are determined for Helical-Axis Advanced Stellarators (Helias). Special emphasis is given to Wendelstein VII-X candidates, for which the magnetic field is produced by a large number of discrete non-planar coils. The investigation is concentrated on the long-mean-free-path regime where particles trapped in local ripple wells of the magnetic field make the dominant contribution to transport. For Wendelstein VII-X, such particles fall into two classes; those localized in the helical ripple common to all stellarator-type devices and those very-localized particles which are trapped in the modular ripples existing between the individual coils. Using analytical techniques it is shown that helical-ripple transport rates are substantially reduced for all Wendelstein VII-X candidates relative to classical stellarator/torsatron configurations. This reduction is most pronounced in the $1/\nu$ regime - equivalent helical ripples of less than 1% lead to reduction factors of more than an order of magnitude - but is significant throughout the entire long-mean-free-path regime. Modular ripple transport in Wendelstein VII-X is calculated by analytically solving the appropriate bounce-averaged kinetic equation. This solution assumes a general magnetic field model and fully accounts for the deformation of modular ripples due to the presence of the other magnetic-field harmonics. Results indicate that 12 coils per field period are necessary if modular-ripple losses are to remain smaller than helical-ripple losses over the entire plasma cross section. (orig.).

23030 (IPP–2/302, pp. 47-56) **Neoclassical transport (DKES code).** Maassberg, H.; Gasparino, U. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The linearized drift kinetic equation which is the basis of the DKES code (Drift Kinetic Equation Solver) is given, approximations in the collision term and in the Vlasov operator are discussed. The relation to Monte Carlo simulation as well as to the formalism based on invariants of motion is shown. Within the DKES formalism, the monoenergetic Onsager transport relation, the energy convolution formalism and the relation to the current drive problem are described. DKES results are compared to axisymmetric models (Monte Carlo Simulation and Hinton-Hazeltine model), the influence of the radial electric field on the transport coefficients is analyzed. For the two W VII-X configurations, HS5081 and HS50B49, the transport coefficients are calculated depending on the collisionality. Finally, the convergence properties of DKES-2 code for typical W VII-X parameters are shown. (orig.).

23031 (IPP–2/302, pp. 57-60) **Calculation of the bootstrap current by direct integration of the drift kinetic equation.** Gardner, H.J.; Boozer, A.H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

An important criterion for distinguishing W VII-X candidates is the expected magnitude of the bootstrap current. We describe a method of calculating the bootstrap current for any (stellarator or tokamak) configuration for which the magnetic field strength and the rotational transform is known. The method is simple and accurate and gives a physical interpretation of the bootstrap current within the kinetic picture. We compare our calculations for three W VII-X configurations with the theory of Shaing and Callen. (orig.).

23032 (IPP–2/302, pp. 123-126) **Neutral gas behaviour in the plasma edge of Wendelstein VII-X.** Scardovelli, R.; Sardei, F. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

For the Wendelstein VII-X configuration HS 5-8, the transport of the neutral gas released by high recycling limiters or wall sectors located in the regions of the strongest plasma outflow has been calculated with the DEGAS code for several plasma density and temperature profiles. In all the cases which have been considered, the neutral density has been found to be highest in front of the sources, dropping radially by at least one order of magnitude to the separatrix and poloidally by two orders of magnitude to the equatorial plane. The average energy of the neutrals hitting the wall has a maximum of 100-200 eV at the location where the distance between the wall and the separatrix is a minimum. This may be critical for impurity sputtering. The flux of energetic charge-exchange neutrals to the wall is reduced by 80% if lateral barriers are placed close to the regions where the plasma outflow is concentrated. (orig.).

23033 (IPP–2/302, pp. 148-163) **Experiments in W 7AS and projections to W 7X.** Renner, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Beginning October 1988, after magnetic surface mapping, first plasma experiments were conducted in the advanced stellarator W 7AS. During the first phase of operation, ECF 70 GHz was used to generate and heat a 'currentless' plasma, which was maintained in quasi-steady state for typically 0.5 s. Up to now the magnetic field had to be restricted to 1.25 T. Therefore, for second harmonic heating the accessible density range is determined by the cut-off density: $n \leq 3 \cdot 10^{19}$ m^{-3}. Restricted by the density limitations for ECF-applications central values of $\beta \leq 0.5\%$ were achieved. Effects of the magnetic configuration on the confinement and measures to deal with the observed plasma current (bootstrap current) by ohmic heating and ECF-current drive were investigated. Preliminary results of transport analysis were compared with predictions of transport models. (orig.).

23034 (IPP–2/302, pp. 164-170) **Plasma parameter estimates for Wendelstein VII-X.** Wobig, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

For predicting plasma parameters in Wendelstein VII-X two methods are available: Scaling laws of global plasma parameters and the TEMPL-code which calculates temperature and density profiles. Global energy confinement times τ_E can be also on the assumption of neoclassical confinement and can be also based on the empirical scaling law established by the LHS-team: τ_E=0.17 anti

$n^{0.69}B^{0.84}P^{-0.58}a^{2}R^{0.75}$, where anti n is the line density, B is the magnetic field, P the heating power. The minor and major radii are a and R, respectively. The units are 10^{20} m^{-3}, T, MW, m. (orig.).

23035 (IPP–2/302, pp. 171-176) **Anomalous transport in tokamaks and stellarators.** Boozer, A. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Anomalous transport in tokamaks is generally assumed to be caused by the drift instabilities, which have the names universal, trapped electron, and η_i modes. The fundamental properties of the drift modes, including the characteristic transport rate, can be obtained without determining whether the modes are actually unstable. These properties are independent of the details of magnetic geometry, so they should be the same in stellarators as in tokamaks. (orig.).

23036 (IPP–2/302, pp. 177-178) **ICRH for W VII-X.** Wesner, F. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Theoretical predictions for ICRH on W VII-X; General ICRH status (tokamak experience); ICRH frequencies and operation modes for W VII-X; ICRH design criteria for W VII-X. (orig.).

23037 (IPP–2/302, pp. 179-185) **ECRH for WVII-X: Heating and current drive.** Erckmann, V. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Application of ECRH at the W VII-X Stellarator in the microwave power range of 5 to 10 MW is discussed on the basis of results obtained at W VII-AS during the first period of operation. At W VII-AS the different rf-beams can be launched independently at arbitrary poloidal and toroidal angles with arbitrary wave polarization, which gives a high flexibility for localized heating and current drive. Shaping of the electron temperature profile from flat to peaked profiles was demonstrated by off- and on-axis power deposition, which may be important to maintain MHD-stability at finite plasma-β in W VII-X. (orig.).

23038 (IPP–4/240) **Current drive via Landau damping of kinetic Alfven wave in toroidal geometry.** Elfimov, A.G.; Puri, S. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Dec 1989. 15p. Order Number DE90759508. Available from NTIS (US Sales Only), PC A03/MF A01.

It is found that Landau-damping of low-phase-velocity ($v_p << v_{te}$, the electron thermal speed) waves is profoundly affected by toroidicity. The proportion α_u of the wave energy imparted to the untrapped particles significantly exceeds their numerical fraction. Computed values of α_u versus v_p/v_{te} are presented. The implications of these results on low-phase-velocity-wave current drive are assessed. (orig.).

23039 (IPP–5/29) **Energy transport in ASDEX in relation to theoretical and semi-empirical transport coefficients.** Gruber, O.; Wunderlich, R.; Lackner, K.; Schneider, W. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Sep 1989. 34p. Order Number DE90759504. Available from NTIS (US Sales Only), PC A03/MF A01.

A comparison of measurements with theoretically predicted energy transport coefficients has been done for Ohmic and NBI-heated discharges using both analysis and simulation codes. The contribution of strong electrostatic turbulence given by the η_i-driven modes to the ion heat conductivity is very successful in explaining the observed response of confinement to density profile changes and is found to be even in good quantitative agreement. Regarding the electron branch, a combination of trapped electron driven turbulence and resistive ballooning modes might be a promising model to explain both the correct power and density dependence of confinement time, and the observed radial dependence of the electron heat conductivity. (orig.).

23040 (IPP–5/30) **A model for periodic pellet ablation in toroidal plasma confinement experiments.** Neuhauser, J.; Wunderlich, R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. 22p. Order Number DE90759505. Available from NTIS (US Sales Only), PC A03/MF A01.

A model is presented for the ablation of a frozen hydrogen pellet moving across field lines into a magnetically confined plasma with emphasis put on the stability of the self-controlled evaporation process. The basic mechanism investigated in detail is the non-locality of the self-shielding as a consequence of the pellet motion relative to the magnetically captured ablation material. Assuming the shielding cloud profile to be given, a one-dimensional model equation is derived which just contains the essential physics of the problem, but also allows for realistic plasma background profiles. The stability of the linearized equation is analytically investigated and the fully nonlinear equation is solved numerically for various scenarions. For small amplitude, an exponentially growing sinusoidal ablation instability is obtained, if there is significant attenuation of the heat influx along field lines and if, at the same time, the shielding cloud profile is sufficiently hollow. The typical spatial wavelength is of the order of the ionization radius. In a homogeneous plasma the instability increases until nonlinear saturation of the amplitude occurs and a quasi-stationary periodic ablation is obtained. For an inhomogeneous background plasma relevant for tokamaks like ASDEX, an ablation signature qualitatively similar to the one experimentally observed is found. We conclude therefore that the non-local shielding mechanism considered is a viable candidate for explanation of the regular striations observed along the pellet path. (orig.).

23041 (IPP–5/31) **The ASDEX integrated data analysis system AIDA.** Grassie, K.; Gruber, O.; Kardaun, O.; Kaufmann, M.; Lackner, K.; Martin, P.; Mast, K.F.; McCarthy, P.J.; Mertens, V.; Pohl, D. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. 36p. Order Number DE90759506. Available from NTIS (US Sales Only), PC A03/MF A01.

Since about two years, the ASDEX integrated data analysis system (AIDA), which combines the database (DABA) and the statistical analysis system (SAS), is successfully in operation. Besides a considerable, but meaningful, reduction of the 'raw' shot data, it offers the advantage of carefully selected and precisely defined datasets, which are easily accessible for informative tabular data overviews (DABA), and multi-shot analysis (SAS). Even rather complicated, statistical analyses can be performed efficiently within this system. In this report, we want to summarise AIDA's main features, give some details on its set-up and on the physical models which have been used for the derivation of the processed data. We also give short introduction how to use DABA and SAS. (orig.).

23042 (IPP–6/285) **Calculation of the resistive ballooning mode growth rate for a class of 3-D MHD equilibria.** Correa-Restrepo, D. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Dec 1989. 7p. Order Number DE90759509. Available from NTIS (US Sales Only), PC A02/MF A01.

A previous derivation of formulae for calculating the growth rate of resistive ballooning modes which are described by a simple model equation is extended here to a large class of general tokamak and stellarator equilibria. (orig.).

23043 (IPP–6/286) **Compressibility and resistive ballooning modes.** Correa-Restrepo, D. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Dec 1989. 7p. Order Number DE90759510. Available from NTIS (US Sales Only), PC A02/MF A01.

For equilibria stable with respect to ideal ballooning modes it is shown by means of a simple argument that, owing to plasma compressibility, resistive ballooning modes with small growth rates can only exist if they are extended along a field line. In particular, a small region of bad curvature along a field line is not sufficient for the existence of unstable modes. (orig.).

23044 (IPP–III/143) **MHD activity during ELMs.** Goeler, S. von; Klueber, O.; Fussmann, G.; Gernhardt, J.; Kornherr, M. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jan 1989. 23p. Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.).

The MHD activity has been monitored in the ASDEX tokamak during ELMs. Besides a fast inward shift of the plasma column, a helical MHD perturbation has been found to accompany every ELM. In general the helical instability has an m number of 3 or 4, an n number of 1, and it propagates in the direction of the electron diamagnetic drift. It seems to be identical with the Toi mode, which had been observed to disappear during L to H transitions. (orig.).

23045 (IR–87-037) **Impact of electron trapping on rf current drive in tokamaks.** Giruzzi, G. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. 1987. 13p. Order Number DE90706048. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Radio-frequency current drive in tokamak plasmas in the presence of trapped electrons is investigated. The appropriate response function, allowing to express the current drive efficiency J/P by a simple analytical formula, is evaluated. It is shown that a significant degradation of the current generated away from the plasma axis is to be expected for methods relying on perpendicular diffusion only, even for appreciably large resonant parallel velocities.

23046 (IR–87-049) **Quasilinear and toroidal effects on current drive by electron cyclotron waves.** Giruzzi, G. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. 1987. 27p. Order Number DE90706049. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Current drive by electron cyclotron waves in toroidal geometry is investigated by means of a bounce-averaged Fokker-Planck code. The case of the extraordinary mode at a frequency lower than the electron gyrofrequency is studied in detail for a wave packet of finite width, carrying a power in the MW range, which is absorbed away from the plasma centre. It is shown that in this case, because of the interplay of quasilinear and trapping effects, (i) the current drive efficiency is strongly power-dependent; (ii) wave absorption at the inboard part of the magnetic surface does not maximize the efficiency, in contrast to the results of linear theory.

23047 (IR–87-058) **A high-beta tokamak equilibrium.** Kleibergen, R.; Goedbloed, J.P. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. 1987. 35p. Order Number DE90706050. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A class of non-circular analytic high-beta equilibria is studied. These equilibria are characterized by three parameters, viz., elongation, triangularity, and shift of the magnetic axis. A non- orthogonal flux coordinate system is constructed analytically which possesses a favourable angular spacing. General expressions for equilibrium quantities in terms of flux coordinates are derived.

23048 (JAERI-M–89-126) **Program package for control system design and analysis (DPACS/J).** Kurihara, Kenichi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Honda, Mitsuteru; Nakamura, Yukiharu; Kimura, Toyoaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1989. 391p. (In Japanese). Order Number DE90759921. Available from NTIS (US Sales Only), PC A17/MF A01.

In order to build an optimal control system, various methods should be applied to control system design and analysis, and many 'cut and try' procedures should be taken for persuading optimality. The useful program package (DPACS/J), which will make it easy to design, and analyze control systems, has been installed in the JAERI computer. This is the manual of DPACS/J. (author).

23049 (JAERI-M–89-157) **Numerical code 'AEOLUS-E1' for analysing free-boundary resistive MHD mode.** Kurita, Gen-ichi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Azumi, Masafumi; Takizuka, Tomonori; Tsunematsu, Toshihide; Takeda, Tatsuoki. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 58p. (In Japanese). Order Number DE90759903. Available from NTIS (US Sales Only), PC A04/MF A01.

Numerical code 'AEOLUS-E1' for analysing a free-boundary resistive MHD mode in a tokamak is developed. Reduced set of the resistive MHD equation is solved as a single-helicity free-boundary problem based on 'pseudo-vacuum' model in a cylindrical geometry. The code can solve problems including effects of coupling to external circuit and interaction between plasma and limiter. (author).

23050 (JAERI-M–89-164) **High βp bootstrap tokamak reactor.** Kikuchi, Mitsuru (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 39p. Order Number DE90759889. Available from NTIS (US Sales Only), PC A03/MF A01.

Basic characteristics of a steady state tokamak fusion reactor is presented. The minimum required energy multiplication factor Q is found to be 20 to 30 for the feasibility of the fusion reactor. Such a high Q steady state tokamak operation is possible, within our present knowledge of the operational constraints and the current drive physics, when a large fraction of the plasma current is carried by the bootstrap current. Operation at high βp ($\geq$2.0) and high qψ (=4-5) with relatively small $\epsilon\beta$p (<0.5) enables to drive bootstrap current up to 70-80% of the total plasma current without deteriorating Troyon beta limit. The rest of the plasma current can be driven by the high energy neutral beam with the energy multiplication factor Q of 30-50. The energy confinement scaling laws predict that the reactor condition is attainable by increasing the major radius (Rp) up to 9m in such a high βp and high q plasma at relatively low plasma current of 12 MA with the confinement enhancement factor of 2 compared with the L-mode scaling. This high βp reactor has a reasonable size (Vp = 1500m^3) and fusion output power (2.5 GW) and is consistent with the present knowledges of the plasma physics of the tokamak, namely the Troyon limit, the energy confinement scalings, the bootstrap current, the current drive efficiency (NB current drive with the total power of 70 MW and the beam energy of 1 MeV) with a favorable aspect on the formation of the cold and dense diverter plasma-condition. From the economical aspect of the tokamak fusion reactor, a more compact reactor is favorable. The use of the high field magnet with Bmax = 16T (for example T_i-doped Nb_3Sn conductor) enables to reduce the total machine size to 50% of the above-described conventional design, namely Rp = 7m, Vp = 760m^{-3}, P_F = 2.8 GW. (author).

23051 (JAERI-M–89-169) **Current drive and sustain experiments with the bootstrap current in JT-60.** Kikuchi, Mitsuru (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Azumi, Masafumi; Tani, Keiji; Tsuji, Shunji; Kubo, Hirotaka. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 42p. Order Number DE90759892. Available from NTIS (US Sales Only), PC A03/MF A01.

The current drive and sustain experiments with the neoclassical bootstrap current are performed in the JT-60 tokamak. It is shown that up to 80% of total plasma current is driven by the bootstrap current in extremely high β_p regime (β_p = 3.2) and the current drive product I_p (bootstrap) n-bar$_e$R$_p$ up to 4.4 x 10^{19} MAm^{-2} has been attained with the bootstrap current. The experimental resistive loop voltages are compared with the calculations using the neoclassical resistivity with and without the bootstrap current and the Spitzer resistivity for a wide range of the plasma current (I_p = 0.5 -2 MA) and the poloidal beta (β_p = 0.1 - 3.2). The calculated resistive loop voltage is consistent with the neoclassical prediction including the bootstrap current. Current sustain with the bootstrap current is tested by terminating the I_p feedback control during the high power neutral beam heating. An enhancement of the L/R decay time than those expected from the plasma resistivity with measured T_e and Zeff has been confirmed experimentally supporting the large non-inductive current in the plasma and is consistent with the neoclassical prediction. A new technique to calculate the bootstrap current in multi-collisionality regime for finite aspect ratio tokamak has bee developed. The neoclassical bootstrap current is calculated directly through the force balance equations between viscous and friction forces according to the Hirshman-Sigmar theory. The bootstrap current driven by the fast ion component is also included.

Ballooning stability of the high β_p plasma are analyzed using the current profiles including the bootstrap current. The plasma pressure is close to the ballooning limit in high β_p discharges. (author).

23052 (JET-R–89-12) **A predictive equilibrium code for JET.** Guo, W.K.; Micozzi, P. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. 1989. 24p. Order Number DE90618740. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new predictive fixed boundary equilibrium code has been developed. This code has two main features. Firstly it is an inverse equilibrium code: it serves to predict what the current should be in the poloidal coils when a plasma with a specific cross-sectional shape is required. Secondly, because it is based on a semi-analytic method and accepts a simple iron core model for the JET transformer, it is a very fast code - it takes less than 10 seconds IBM 3090 CPU time for one result. In comparison with the experimental data, the validity of the code has been proven. (author).

23053 (JET-R–89-13) **3/2 or 5/2 for convective thermal transport?.** Duechs, D.F. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Jul 1989. 13p. Order Number DE90618599. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

To resolve frequent arguments on the form of the convective part of the thermal energy flux the relevant definitions and equations are compiled. The relative importance of the different terms involved is shown for Joint European Torus (JET) data. The choice of the "adiabatic source terms", p"centre dot"div v- "->" or v- "->centre dot"grad p, decides the form of the convective heat flux. (author).

23054 (JET-R–89-15) **Gas release on venting the JET torus.** Coad, J.P. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. 1989. 13p. Order Number DE90618741. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

On a number of occasions when Joint European Torus (JET) has been vented, the air in the vessel has been sampled prior to opening any flanges. Large amounts ($\approx 1.3 \times 10^{23}$ atoms) of deuterium are found to have been released from the walls, together with a proportion of the tritium previously produced for (d-d) reaction. A far larger amount of tritium (comparable to the deuterium level above) would be released in the active phase of JET. The amount released can be greatly reduced by carbonising before venting, or by venting the vessel and re-evacuating prior to the venting for personnel access. (author).

23055 (KEK–89-14) **Proceedings of the workshop on role of plasmas in accelerators.** Ogata, Atsushi (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. 101p. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

This issue is the collection of the papers presented at the title meeting. The 8 of the presented papers are indexed individually. (J.P.N.).

23056 (LA-UR–90-692) **New methods in plasma simulation.** Mason, R.J. Los Alamos National Lab., NM (USA). 23 Feb 1990. 28p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-891182–3: International conference on plasma physics, New Delhi (India), 22-28 Nov 1989). Order Number DE90007507. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The development of implicit methods of particle-in-cell (PIC) computer simulation in recent years, and their merger with older hybrid methods have created a new arsenal of simulation techniques for the treatment of complex practical problems in plasma physics. The new implicit hybrid codes are aimed at transitional problems that lie somewhere between the long time scale, high density regime associated with MHD modeling, and the short time scale, low density regime appropriate to PIC particle-in-cell techniques. This transitional regime arises in ICF coronal plasmas, in pulsed power plasma switches, in Z-pinches, and in foil implosions. Here, we outline how such a merger of implicit and hybrid methods has been carried out, specifically in the ANTHEM computer code, and demonstrate the utility of implicit hybrid simulation in applications. 25 refs., 5 figs.

23057 (LRP–386/89, pp. 3) **Quasi-optical gyrotron: present status and future prospect.** Tran, M.Q. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A review of the main experiments on quasi-optical gyrotron is presented. Methods to improve the efficiency (pencil beam electron gun and depressed collector) will be discussed. (author) 5 figs., 1 tab., 10 refs.

23058 (LRP–392/90) **Review of free-electron-laser (FEL) simulation techniques.** Tran, T.M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Wurtele, J.S. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jan 1990. 30p. Order Number DE90618601. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper we review the techniques employed in the numerical simulations of free-electron-laser, in the amplifier as well as the oscillator configuration. Special emphasis is given to the numerical problems associated with the particle initialization (particle loading), the treatment of the paraxial equation, the inclusion of oscillating space charge forces in the longitudinal particle motion and the multi-frequency modelling. This overview does not however include the particle-in-cell simulations commonly utilized in plasma physics: due to the large scale between the wiggler and the radiation wavelength, this type of technique is impractical for short wavelength free-electron-laser. (author) 2 figs., 37 refs.

23059 (LRP–394/90) **On spectral pollution.** Llobet, X. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Appert, K.; Bondeson, A.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jan 1990. 34p. Order Number DE90618602. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Finite difference and finite element approximations of eigenvalue problems, under certain circumstances exhibit spectral pollution, i.e. the appearance of eigenvalues that do not converge to the correct value when the mesh density is increased. In the present paper this phenomenon is investigated in a homogeneous case by means of discrete dispersion relations: the polluting modes belong to a branch of the dispersion relation that is strongly distorted by the discretization method employed, or to a new, spurious branch. The analysis is applied to finite difference methods and to finite element methods, and some indications about how to avoiding polluting schemes are given. (author) 5 figs., 10 refs.

23060 (N–90-14102) **Experimental and theoretical study of artificial plasma layers produced by two intersecting beams in a chamber.** Kuo, S.P.; Zhang, Y.S. Polytechnic Univ., Farmingdale, NY (USA). Weber Research Inst. Oct 1989. 42p. (NASA-CR–184598;NAS–1.26:184598). Available from NTIS, PC A03/MF A01.

The work done on the Bragg scattering of electromagnetic waves by microwave produced plasma layers is reported. Also summarized is the work accomplished on the propagation of high power microwave pulses in an air breakdown environment. Ongoing work on the theoretical model and numerical results of pulse propagation in air is also presented as are the results of studying the decay of plasma density and temperature.

23061 (N–90-14910) **High-frequency instability of the sheath-plasma resonance.** Stenzel, R.L. California Univ., Los Angeles, CA (USA). 1989. 43p. (NASA-CR–186127;NAS–1.26:186127). Available from NTIS, PC A03/MF A01.

Coherent high frequency oscillations near the electron plasma frequency (omega approx. less than omega sub p) are generated by electrodes with positive dc bias immersed in a uniform

Maxwellian afterglow plasma. The instability occurs at the sheath-plasma resonance and is driven by a negative RF sheath resistance associated with the electron inertia in the diode-like electron-rich sheath. With increasing dc bias, i.e., electron transit time, the instability exhibits a hard threshold, downward frequency pulling, line broadening and copious harmonics. The fundamental instability is a bounded oscillation due to wave evanescence, but the harmonics are radiated as electromagnetic waves from the electrodes acting like antennas. Wavelength and polarization measurements confirm the emission process. Electromagnetic waves are excited by electrodes of various geometries (planes, cylinders, spheres) which excludes other radiation mechanisms such as orbitrons or beam-plasma instabilities. The line broadening mechanism was identified as a frequency modulation via the electron transit time by dynamic ions. Ion oscillations at the sheath edge give rise to burst-like RF emissions. These laboratory observations of a new instability are important for antennas in space plasmas, generation of coherent beams with diodes, and plasma diagnostics.

23062 (N–90-14934) **Particle simulations in magnetospheric plasmas. Final Technical report, 1 November 1988-31 October 1989.** Nishikawa, K. Iowa Univ., Iowa City, IA (USA). Jan 1990. 7p. (NASA-CR–186238;NAS–1.26:186238). Available from NTIS, PC A02/MF A01.

In view of the recent remarkable advancement of computer technology and simulation software, simulation studies are one of the most powerful academic tools for establishment of quantitative space physics and modelling of our space environment. The complex nature encountered in space plasma physics has motivated considerable development in computer simulations, which have played an essential role in the development of space plasma theory. This report describes research undertaken to understand physical processes involved in plasma waves observed in the magnetospheric plasmas, and associated nonlinear phenomena such as heating, diffusion, and acceleration of particles due to excited waves. The research explains and clarifies the observational data both qualitatively and quantitatively.

23063 (ORNL/FEDC–89/3) **TSC [Tokamak Simulation Code] disruption scenarios and CIT [Compact Ignition Tokamak] vacuum vessel force evolution.** Sayer, R.O.; Peng, Y.K.M.; Strickler, D.J.; Jardin, S.C. Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center. Jan 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008087. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Tokamak Simulation Code and the TWIR postprocessor code have been used to develop credible plasma disruption scenarios for the Compact Ignition Tokamak (CIT) in order to predict the evolution of forces on CIT conducting structures and to provide results required for detailed structural design analysis. The extreme values of net radial and vertical vacuum vessel (VV) forces were found to be F_R=−12.0 MN/rad and F_Z=−3.0 MN/rad, respectively, for the CIT 2.1-m, 11-MA design. Net VV force evolution was found to be altered significantly by two mechanisms not noted previously. The first, due to poloidal VV currents arising from increased plasma paramagnetism during thermal quench, reduces the magnitude of the extreme F_R by 15-50% and modifies the distribution of forces substantially. The second effect is that slower plasma current decay rates give more severe net vertical VV loads because the current decay occurs when the plasma has moved farther from midplane than is the case for faster decay rates. 7 refs., 9 figs., 1 tab.

23064 (PB–90-130089/XAB) **Resistive and eruptive instability by ponderomotive force with high-frequency plasma oscillations.** Li, X.Q.; Wu, S.T. Alabama Univ., Huntsville, AL (USA). Dept. of Mechanical Engineering. c 1989. 30p. Available from NTIS, PC A03/MF A01.

Pub. in Laboratory and Space Plasmas, 239-265(1989).

The authors investigated the subtle interaction between the magnetohydrodynamic (MHD) and high-frequency plasma waves and they derived the coupling equations for the phenomena. On the basis of the formalism, they examined the modulation instabilities by an electromagnetic soliton in a current sheet and showed that there is a resistive instability for constant-psi approximation (i.e., uniform magnetic field configuration), which eventually turns into an eruptive instability at the onset of the magnetic field reconnection.

23065 (PPPL–2655) **How temperature gradients are determined in toroidal plasmas.** Yoshikawa, Shoichi. Princeton Univ., NJ (USA). Plasma Physics Lab. Feb 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008776. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

It is commonly assumed in modern-day toroidal plasmas that the edge ion or electron temperature is sufficiently low so that the edge temperature can be neglected with respect to the center temperature. For example, in a detached plasma, where the boundary condition is understood reasonably well, it is both theoretically and experimentally justified to say that the edge temperature can be approximately zero. Now in a toroidal plasma bounded by a divertor, it is theoretically possible to design a divertor such that each pair of electron and hydrogen ion can carry, on average, 3/2(kTe + kTi). Then, in the absence of recycling, the temperature gradients in the scrape-off layer can be made zero or at least, less than 1/a, where a is the plasma radius. Under that boundary condition, the temperature gradient inside the plasma vanishes. Realizing this in practice is difficult but not impossible. The problem is discussed in this paper. 1 ref.

23066 (PPPL–2680) **Waves in plasmas: Highlights from the past and present.** Stix, T.H. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. (CONF-891106–10: 31. annual meeting of the Division of Plasma Physics of the American Physical Society; Joint conference of the 6. international conference on plasma physics and on the 6. international congress on plasma waves and plasma instabilities, A Order Number DE90008004. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

To illustrate the development of some fundamental concepts in plasma waves, a number of experimental observations, going back over half a century, are reviewed. Particular attention is paid to the phenomena of dispersion, collisionfree damping, ray trajectories, amplitude transport, plasma wave echos, finite-Larmor-radius and cyclotron and cyclotron-harmonic effects, nonlocal response, and mode conversion. Also to the straight, trajectory approximation and two-level phase mixing. And to quasilinear diffusion and its relation to radiofrequency heating, current drive and induced neoclassical transport, and to stochasticity and superadiabaticity. One notes not only the constructive interplay between experiment and theory but also that major advances have come from each of the many disciplines that invoke plasma physics as a tool, including radio communication, astrophysics, controlled fusion, space physics, and basic research. 47 refs., 33 figs.

23067 (RAL–89-089) **Dusty plasmas.** Tsytovich, V.N. (USSR Academy of Sciences, Moscow (USSR). Inst. of General Physics); Morfill, G.E.; Bingham, R.; Angelis, U. de. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 16p. Order Number DE90618742. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The field of "dusty plasmas" promises to be a very rewarding topic of research for the next decade or so, not only from the academic point of view where the emphasis is on developing the theory of the often complex collective and non-linear processes, but also from the point of view of applications in astrophysics, space physics, environmental and energy research. In this "comment" we should like to sketch the current development of this fast growing and potentially very important research area. We will discuss the new features of "dusty" plasmas in the most general terms and then briefly mention some successful applications and effects which have already been examined. (author).

23068 (RAL–89-090) **Electromagnetic wave scattering in turbulent plasmas.** Bingham, R. (Rutherford Appleton Lab., Chilton (UK)); Angelis, U. de; Tsytovich, V.; Evans, D.; Lashmore-Davies, C.N. Rutherford Appleton Lab., Chilton (UK). Sep 1989. 15p. Order Number DE90618732. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We describe for the first time the theory of electromagnetic wave scattering in a turbulent plasma taking into account the nonlinear plasma responses due to the presence of turbulence. It is shown

that the presence of turbulence in the form of Langmuir waves introduces an extra expression in the dielectric function. This extra term is the non-linear susceptibility of the plasma due to the turbulent wave fields. It is shown that this extra term in the dielectric function produces a different expression for the dynamic form factor $S(k,\omega)$ which is related to the cross section for the scattering of an electromagnetic wave by electrons. (author).

23069 (Rijnhuizen-report–89-186, pp. 10-18) **A polarizing mirror for electron cyclotron resonance heating on RTP.** Smits, F.M.A. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica (Netherlands)). NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. (CONF-8905159–: Joint IAEA technical committee meeting on ECE and ECRH and 7th joint workshop on ECE and ECRH (EC-7), Hefei (China), 8-11 May 1989). In *FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.* Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A means of producing a wide range of elliptical polarizations of an electromagnetic wave by using a rotatable corrugated mirror at arbitrary total reflection angles and a variable polarization direction of the linearly polarized incident wave is presented. For the description of the reflection process, TM- and TE-like modes are defined. The phase shift between them determines the range of elliptical polarizations that can be achieved at given angles of incidence. The phase shift has been calculated for mirrors with rectangular grooves. A method has been developed to determine the phase shift from measurements on the reflected field. Experimental results are in good agreement with theory. The polarization method has been implemented for use on RTP, the Rijnhuizen Tokamak Project, and the mirror dimensions have been optimized for this purpose. (author). 7 refs.; 6 figs.

23070 (Rijnhuizen-report–89-186, pp. 19-31) **Electron cyclotron heating of high density jet H-mode discharges.** Westerhof, E. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica (Netherlands)); Polman, R.W.; Schep, T.J. NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. (CONF-8905159–: Joint IAEA technical committee meeting on ECE and ECRH and 7th joint workshop on ECE and ECRH (EC-7), Hefei (China), 8-11 May 1989). In *FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.* Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The potentially of Electron Cyclotron Heating (ECH) in high performance, high density JET H-mode discharges is studied. The aim is to show well localized, central heating with EC waves at densities n_e 1.0 to 1.5 10^{20} m^{-3}. The other plasma parameters are taken in the range B_T = 3.0 to 3.7 T and T_e = 5 to 10 keV. Ray-tracing calculations are used to analyze the options for ECH which include both first and second harmonic ordinary (O-mode) and extraordinary (X-mode) waves. The second harmonic X-mode appears to be the best choice, while the first harmonic O-mode is a good alternative if the central density does not exceed 1.0 10^{20} m^{-3}. Calculations of the power deposition profile for a realistic launching system show good central heating with second harmonic X-mode waves. (author). 6 refs.; 9 figs.; 1 tab.

23071 (Rijnhuizen-report–89-186, pp. 32-45) **Electron cyclotron current drive and m=2 mode stabilization in NET.** Giruzzi, G. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica (Netherlands)); Schep, T.J.; Westerhof, E. NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. (CONF-8905159–: Joint IAEA technical committee meeting on ECE and ECRH and 7th joint workshop on ECE and ECRH (EC-7), Hefei (China), 8-11 May 1989). In *FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.* Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Current drive by electron cyclotron waves (ECCD) in the Next European Torus is investigated. The profile and the efficiency of the driven current are calculated with a 3-dimensional bounce averaged Fokker-Placnk code coupled to a toroidal ray-tracing code. This study consists of two parts. In the first part the application of EC waves to drive the central part of the main plasma current for steady state operation is studied. It is shown taht the highest current drive efficiencies are obtained using the ordinary wave at up-shifted frequency ($\omega > \omega_c$). The maximum obtainable efficiency is limited by overlap with the second harmonic resonance and is given by $\eta \approx 0.3 A W^{-1}$ $10^{20} m^{-2}$. Off-axis, this efficiency is reduced by a factor of 2 due to trapped particles. In the second part, the application of ECCD for control of the current profile around the q=2 surface to prevent growth of the m=2, n=1 tearing mode is studied. In all cases studied, the injection of 10 MW of EC wave power at the appropriate frequency and injection angle is sufficient to stabilize the m=2, n=1 tearing mode. (author). 11 refs.; 5 figs.; 2 tabs.

23072 (Rijnhuizen-report–89-186, pp. 46-53) **A double-heterodyne ECE radiometer for the measurement of small temperature fluctuations on RTP.** Verreck, M. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica (Netherlands)); Hugenholtz, C.A.J. NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. (CONF-8905159–: Joint IAEA technical committee meeting on ECE and ECRH and 7th joint workshop on ECE and ECRH (EC-7), Hefei (China), 8-11 May 1989). In *FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.* Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A 20-channel double-conversion superheterodyne radiometer to diagnose second harmonic X-mode ECE emission from a new tokamak experiment, the 'Rijnhuizen Tokamak Project' (RTP), is under development. The main purpose of this diagnostic will be the measurement of electron-temperature fluctuations, which are suspected to play an important role in anomalous transport and heat loss effects. The double-conversion technique is characterized by the application of two frequency conversion steps for each channel. This approach offers the opportunity to do the main part of the signal handling, like bandwidth selection and amplification, on a low frequency level (< 1 GHz) where relative low cost and 'easy to manufacture' components are available. The application of this technique will increase the flexibility of radiometer systems for ECE measurements and offers the best resolution properties now possible. (author). 3 refs.; 1 fig.; 1 tab.

23073 (UCRL–21233) **Power threshold for neutral beam current drive.** Politzer, P.A. (General Atomics, San Diego, CA (USA)); Porter, G.D. Lawrence Livermore National Lab., CA (USA). 2 Oct 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48;AC03-89ER51114. Order Number DE90008348. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

For fully noninductive current drive in tokamaks using neutral beams, there is a power and density threshold condition, setting a minimum value for $P^{3/2}/n^2$. If this condition is not met, stationary state cannot occur, and a tokamak discharge will collapse. This is a consequence of the coupling between current and electron temperature, or between current drive efficiency and energy confinement time. 4 figs.

23074 **Process diagnostics: Materials, combustion, fusion.** Materials Research Society symposium proceedings. Volume 117. Hays, A.K. (Sandia National Labs., Albuquerque, NM (USA)); Eckbreth, A.C.; Campbell, G.A. 322p. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

The book contains papers in the areas of combustion and fusion designed to overview major diagnostic techniques (laser-induced fluorescence, spontaneous Raman spectroscopy, interferometry,

imaging, Langmuir probes, multiphoton exitation/detection techniques, etc.) as applied to combustion and fusion processes. The materials processing diagnostic papers represent the current state-of-the-art diagnostics in such areas as plasma etching, CVD, PACVD, welding, vacuum arc remelting, metal extrusion, and plasma spraying.

23075 **Theory of voltage decay in applied-B ion diodes.** Desjarlais, M.P. (Sandia National Labs., Albuquerque, NM (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The author reports how a proposed theory of applied-B ion diodes has proven successful in predicting the diode voltage and current at peak power in several experiments and numerical simulations. For times after peak power, the basic theory is in good agreement with simulations but does not predict the experimentally observed voltage decay, suggesting a mechanism involving the anode plasma. The theory predicts a divergent ion current at a critical, limiting voltage $V_* = 0.6cBo^d$. Since the diode voltage is limited by the flux in the A-K gap, penetration of magnetic flux behind the active anode surface can result in decay of the diode voltage. If the voltage decay is driven by flux penetration, the ion beam should reflect this process through the change in the ion beam focus that is dictated by angular momentum constraints. The flux loss inferred from experimental measurements of the ion beam motion is in good agreement with theoretical calculations of the flux loss required to explain the experimental voltage and current traces. A simple model of the flux penetration is found to be in good agreement with a number of experiments for very reasonable layer densities and velocities.

23076 **Observation of strong oscillations in an expanding plasma.** Hairapetian, G. (California Univ., Los Angeles, CA (USA). Dept. of Physics (USA)); Stenzel, R.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors describe strong oscillations of plasma potential and density observed in a two-electron-population plasma which is expanding into vacuum along an external magnetic field. During the expansion, ions are accelerated to very high energies. Preliminary observations indicate that the oscillations exists only in the presence of a cross-field electric field which self-consistently develops. The magnitude and direction of the electric field is a sensitive function of background neutral pressure and the magnetic field. A two-probe correlation measurement was performed to determine the wavenumber of the dominant mode in the observed oscillations. Initial results are reported.

23077 **High power microwave generation and particle accelerators.** Nation, J.A. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The peak energy achieved in particle accelerators has increased by a factor of about 25 every decade since the 1930's. During the same interval the cost per MeV has decreased by a factor of about 16 per decade. Much of the increase in the particle energy available per dollar can be attributed to advances in microwave generation. In this review an account is presented describing some of the recent advances in ultra high power microwave generation and in the drivers for the microwave sources. The relevance of pulse power to microwave generation is emphasized and the constraints placed on the source by the accelerator requirements indicated. A discussion of other pulse power driven accelerator technologies is presented.

23078 **Experimental investigation of a localized electron temperature elevation near electron cyclotron resonance.** Lam, S.W. (Wisconsin Univ., Madison, WI (USA)); Mett, R.R.; Bettenhausen, M.; Scharer, J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors examine detailed properties of a plasma/wave interaction in an inhomogeneous magnetic field. An electron cyclotron resonant cavity produces a plasma column which is tuned so that an electron cyclotron wave launched from a helical antenna couples to the plasma. It then interacts with the Langmuir probe to produce a localized electron temperature elevation. They have studied its dependence on launched wave frequency, plasma density, neutral pressure, and plasma source tuning. Langmuir probes with different impedances are used to illustrate the dependence of the temperature elevation phenomena on probe impedance. It is found that the temperature elevation process is maximum when the probe is near but substantially shifted from the cold electron cyclotron resonance position in a inhomogeneous plasma. Collisionless wave absorption near resonance, magnetic field and the plasma source tuning play important roles in determining the temperature elevation phenomenon. Two probe correlation measurements are carried out to determine the radial and axial extent of the elevation. These measurements are used to construct a model for the temperature elevation mechanism.

23079 **Measurement of sheath potential in an RF inductive discharge plasma with a DC magnetic field.** Kim, G.H. (Wisconsin Univ., Madison, WI (USA)); Cho, M.H.; Hershkowitz, N.; Doczy, M.; Davis, T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The structure of a sheath near a biased electrode depends on the orientation of magnetic field relative to the plate. In the presence of an oblique magnetic fields, it has been claimed that the sheath exhibits a double structure consisting of an electrostatic sheath the order of a Debye length and a magnetic sheath, the order of the ion-gyroradius evaluated at the ion sound speed. Measurements of sheath potential, occurring in front of negatively or positively biased plate, are performed in the presence of external DC magnetic field with nearly parallel or perpendicular orientations to the plate. Measurements were made in an electrodeless rf induction plasma in a multidipole device. This source uses a single turn loop antenna made out of an enamel coated copper strip, and operates at frequencies ranging from ~1MHz to ~20MHz depending on the tuned resonance frequency, and at the neutral gas pressure $>5x10^{-5}$ torr. It has been operated with DC magnetic fields, up to ~ gauss, and strong ECR effect has been observed. Plasmas produced at low neutral pressure ($<1x10^{-3}$ torr) have good spatial uniformity independent of magnetic field direction. The results of sheath measurements by emissive probes are presented together with the detailed characteristics of the plasma.

23080 **Electron collisions with processing plasma constituents.** Becker, K.H. (City Coll., New York, NY (USA). Dept. of Physics). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors are engaged in an experimental program that studies the electron-impact dissociation of NF_3, CF_4, SF_6, BCl_3 and CCl_2F_2 which are among in the most commonly employed reactive constituents of etchant gas plasmas. It is the objective of their research to determine absolute cross sections and appearance potentials for the formation of the various radiating, metastable and neutral ground-state fragments that are produced by controlled electron impact dissociation of these molecules. Experimental techniques employed include electron and optical emission spectroscopy, mass spectroscopy as well as time-of-flight (TOF) and laser-induced fluorescence (LIF) techniques. This paper focuses on molecular emissions in the near ultraviolet region of the optical spectrum. The authors discuss the emission of the BCl A yields X

band system from BCl_3, the CCl A yields X and CCl^+ A yields X band systems from CCl_2F_2 as well as continuous UV emissions following dissociative electron impact on SF_6 and NF_3.

23081 A study of binary ion plasma expansion into laboratory generated plasma wakes. Wright, K.H. (Marshall Space Flight Center, Hunts., AL (US)); Stone, N.H.; Samir, U. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report plasma expansion into the wake of a large rectangular plate immersed in a collisionless, supersonic, binary ion plasma investigated in laboratory experiments. A new plasma source has been developed to generate equi-velocity, binary ion plasma flows, which allows access to new dimensions in parameter space that have previously been unavailable for laboratory studies. Specifically, the new parameters are the ionic mass ratio and the ionic component density ratio. In a series of experiments, a krypton-neon plasma (mass ratio of 4.15) is employed where the ambient density ratio of neon to krypton is varied more than an order of magnitude. The expansion is limited to early times;i.e., a few ion plasma periods, by the combination of plasma density, plasma drift speed, and vacuum chamber size. New experimental results include the propagation of a rarefaction wave for each ionic component into the ambient plasma; the formation of a plateau-like region in the neon (the lighter mass) ion current density when the neon ions are the minor ionic species in the ambient plasma; and the acceleration of both ionic species, with neon accelerating at a higher rate than krypton. Results of this study, together with those from previous single ion plasma experiments, indicate that the plasm expansion process is the dominant filling mechanism of the near wake of a body under these experimental conditions.

23082 Experimental investigation of hemispherical ion-beam modes. Garner, C.E. (University of South Florida, Tampa, FL (USA). Dept. of Physics). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper is concerned with ion-beam modes that have been produced in a double plasma device in which the driver and target plasmas are separated by a hemispherical grid biased negatively with respect to both plasmas. Both single pulses and continuous pulse trains were excited in the target plasma by application of a voltage pulse to a hemispherical grid. Detection was accomplished with a positively-biased spherical probe capable of axial and rotational movement. Spatial evolution of the wave amplitude along the axis of the hemispherical grid was detected over a distance of more than two grid radii. An increase in wave amplitude and wave phase velocity as the wave approached the geometrical focal point of the grid is predicted by the equations for wave amplitude and phase velocity for spherical ion-beam modes that we have derived using the fluid equations. The dependence of the wave phase velocity on the ion-beam speed indicates that the waves found were hemospherical ion-beam modes.

23083 TOF electron drift measurements in xenon difluoride (XeF_2) and hydrogen sulfide (H_2S) gas mixtures. Denman, C.A. (Air Force Weapons Lab., Kirtland AFB, NM (USA)); Schlie, L.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report sensitive high-temporal resolution time-of-flight (TOF) drift measurements yielding the drift velocity (V_d), longitudinal diffusion (D_L) and a new, higher-order, diffusion coefficient (D_3) obtained in the gases XeF_2 and H_2S. The investigation into the transport properties of these gases is of interest because of their potential as a lasing constituent when combined with the highly energetic (8.5 MJ/kg) hydrogen azide (HN_3) gas. Kinetic studies indicate that a hybrid electro-chemical laser using a mixture of XeF_2/HN_3 might produce high densities of XeF(B) (B→X, 3511A) via an electrically initiated chain chemical reaction. Using conservative estimates for transfer efficiencies, such densities correspond to laser energies approaching 400J/liter. Similarly, a high energy S_2 laser (S_2(B→X), 3837.5A) using an H_2S/HN_3 mixture is a possibility.

23084 Plasma breakdown behavior of hydrogen azide (HN_3) gas mixtures. Schlie, L.A. (Air Force Weapons Lab., Kirtland AFB, NM (USA)); Wright, M.W.; Denman, C.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Recent work on electron beam initiated plasma studies has shown that HN_3 is a strong electron attaching molecule. In an attempt to better understand the plasma transport properties of this particular azide gas, the electrical breakdown behavior of HN_3 was investigated. There was a marked difference in the breakdown phenomena for different pressures of buffer gases. With HN_3 pressures of a few torr mixed with an atm. of inert gas, the plasma breakdown constituency of the original species is retained. In pure hydrogen azide gas, its breakdown creates a chain chemical reaction producing very intense N_2 first and second positive band emission. In addition, such a breakdown causes the molecular constituency of the gas to change from HN_3 to only H_2 and N_2, as determined by a mass spectrograph. Upon completion of the plasma initiated chain reactions, a factor of two pressure increase is always observed due to the stoichiometry of the pertinent reactions. The transient spectral behavior elucidates the kinetic processes occurring in this gas. The effect of gas temperature on the kinetics of this system is discussed. The implication of such plasma breakdown processes on potential hybrid electro-chemical lasers is described.

23085 Electron temperature and current density measurements at the anode of free burning, high intensity arcs. Leveroni, E. (Univ. of Minnesota, MN (US)); Pfender, E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report on the plasma near the anode of free-burning high-intensity argon arcs, characterized by strong deviations from thermal and chemical equilibrium, investigated by means of electric probes. This diagnostic technique is appropriate since it provides data which can be interpreted without assumptions about the thermodynamic state of the plasma. Measurements of electron and ion current density and electron temperature on the arc centerline were obtained using a probe flush with the anode surface. The results clarify the effects of arc current, electrode gap, and operating pressure on the properties of the boundary layer. In addition, they may affect the scale-up, optimization and electrode life expectancy criteria for such arcs in terms of the correct estimation of anode heat fluxes. Two-temperature non-equilibrium is shown to prevail with electron temperatures remaining around or above 10000 K in spite of the presence of the water cooled anode. The electron current density data for atmospheric pressure arcs show a non-monotonic dependence on the overall arc current, displaying a minimum which, for the shorter electrode gaps, is very pronounced. The probe characteristics indicate that the anode indeed may also collect ions from the plasma.

23086 Compressional Alfven waves in A B field gradient. Intrator, T. (Dept. of Nuclear Engineering and Engineering Physics, Univ. of Wisconsin-Madison (US)); Meassick, S.; Hershkowitz, N. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 4C4.

In the Phaedrus-B Tandem Mirror experiment, the authors excite compressional and torsional Alfven waves that can heat the plasma. At the end of the central cell of this device, the wavelengths are the same order as the parallel mirror magnetic field gradient length. Using detailed experimental diagnostics, they can

display the wave characteristics in the uniform and non uniform regions of the plasma. Their understanding of these types of waves is hampered by the non uniformity in the background plasma and magnetic mirror field which not only couples the fast and slow modes, but also makes theory very difficult. The physics of this type of problem may be relevant to geomagnetic pulsations and perpendicular ion heating in the ionosphere. Electromagnetic and electrostatic wave fields have been measured with B dot probes and capacitive emissive probes in a full two dimensional plane. The spatial dependence of the wave amplitudes, phases and polarization indicate that the fast wave magnetic fields are localized away from the mirror region with large electrostatic fluctuations and polarization change in the mirror region. The possibilities that wave energy could either be mode converted, reflected or both are examined.

23087 RF field measurements in the vicinity of an ICRF antenna. Majeski, R. (Univ. of Wisconsin-Madison (US)); Intrator, T.; Roberts, D.; Hershkowitz, N.; Tataronis, J.; Grossmann, W. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 4C5.

Measurements of the rf fields near an ICRF antenna installed in the central cell of the Phaedrus-B tandem mirror have been made, both in vacuum and in the presence of plasma. The antenna is a Faraday shielded partial turn loop. The front surface of the Faraday shield is composed of cylindrical elements in an arrangement similar to the Faraday shield design employed on TFTR. The antenna is run at relatively low power levels, in the 3.5-10 MHz frequency range. Two other ICRF systems in the phaedrus-B central cell sustain and heat the plasma at the 400 KW level. The vacuum field measurements are compared with the predictions of the ARGUS code, which models details of the Faraday shield structure. Fields in the plasma are modelled by the ANTENA code. Particle currents collected by the Faraday shield during plasma operation are also observed.

23088 Feedback control of a polymer producing glow discharge plasma. Hershkowitz, N. (Wisconsin Univ., Madison, WI (USA)); Cho, M.H.; Pruski, J.; Dekock, J.; Anderson, P. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Glow discharges are produced in a conventional parallel plate device using either propylene and argon. The propylene discharge differs from the argon discharge in that polymers are continuously deposited at the plasma boundaries. Langmuir probe Current- Voltage (I-V) characteristics are monitored with a heated mesh probe, heated "red" to prevent polymer formation on the probe in the propylene system. A PC monitors I-V characteristics every 30 seconds and compares to the authors focus on how, in the present mode of operation, the PC adjusts the gain of the glow discharge rf amplifier and maintains a desired I-V characteristic as wall conditions, etc. change. Later versions are expected to include control of the neutral as pressure and flow rate. System operation is evaluated with and without polymer formation by operating with propylene and with argon.

23089 Optimization of the efficiency in gyrotron backward wave oscillator model via tapered axial magnetic field. Ahn, S. (Naval Research Lab., Washington, DC (USA)); Ganguly, A.K. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The nonlinear evolution of the gyrotron backward wave oscillator (gyro-BWO) is investigated numerically in the presence of a tapered axial magnetic field. The set of coupled nonlinear differential equations which govern the self-consistent evolution of the TE modes and the trajectories of an ensemble of electrons in a gyrotron are solved subject to boundary conditions for both the usual BWO (power extracted at the input end) and the reflection type BWO (power extracted in the forward direction) configurations.

23090 Neutron production in deuterium-nobel gas mixtures in a plasma focus. Deeney, C. (Physics International Co., San Leandro, CA (USA)); Choi, P.; Herold, H. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report experiments on the DPF 78 plasma focus (60 kV, 28 kJ) which have shown that the neutron production occurs predominantly at the time of the hard X-ray pulse. This pulse is produced by a relativistic electron beam (REB). A Cerenkov detector and an X-ray streak camera system are used to prove that this REB is generated at the time of the plasma maximum compression, come 25 ns before the plasma becomes m=0 unstable. The neutron pulse is not observed if there is no REB. This fact and the correlation between the risetime of the plasma optical emission and the risetime of the neutron pulse, indicate that the neutrons have a beam-plasma origin at this time. The theory that the neutron emission could be produced by a thermal plasma, such as the hot spots is also investigated by studying the scaling as the high Z dopant is varied. It has been observed that as the percentage of high Z dopant is increased the neutron emission decreases even though the number and brightness of the hot spots increase. A thermal origin is not completely dismissed, however, because on some shots a second neutron pulse was observed after the m=0 instability. In this paper, multi-keV electron temperature plasma is shown to exist.

23091 Z-pinch characteristics of the Tandem Puff. Thompson, J. (Maxwell Labs., Inc., San Diego, CA (USA)); Davis, P.; Loter, N.; Rauch, J.; Ware, K. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The Tandem Puff uses a coaxial gun geometry based on the dense plasma focus but without a breach insulator to generate a fast Z-pinch. Operating in vacuum the Tandem Puff uses ionized plasma from flashboards along the coaxial section to provide the initial current path in the breach and to support the axial snowplow phase of operation. The gas imploded in the fast Z-pinch phase at the end of the inner electrode is injected by a magnetically driven fast valve. The authors report experiments characterizing the Tandem Puff using neon as the working gas have been performed using ACE, a 250 kJ, 120 kV capacitor bank. With a quarter period of about 3 μs, operation of the bank at 100 kV resulted in peak drive current approaching 1.5 MA. The Z-pinch was characterized by a number of diagnostics including filtered calorimeters and XRD's, a soft pinhole camera, a spectrometer, an Imacon 790 camera used in both streak and framing mode, and current monitors.

23092 Characterization of a novel alkali metal and transition metal plasma source. Beaudry, A. (Idaho Univ., Moscow, ID (USA). Dept. of Chemical Engineering); Morin, T.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Results of characterization studies of a metal vapor plasma, and potentially an ion source, are presented. The source is well suited to solids having dielectric and thermal properties which permit rapid heating of the solid by a high-frequency (2-3 GHz) signal. By proper placement in a resonant cavity, the conductively and dielectrically heated solid surface emits a vapor stream which is then ionized in the near-surface region, yielding a metal ion rich plasma. The work presented here concerns plasmas produced from two alkali metal halides, NaCl and KBr, as well as from graphite, titanium dioxide, and iron oxide. The power densities involved are characteristic of high-frequency plasmas and range from 1 to 30 W/cm^3. The factor of two or three difference between the ionization potentials of the metals and of the halides or oxygen results in an

enrichment of the metal ion content of the plasma and in the presence of the halides or oxygen as atoms rather than ions. In addition to the description of the novel source, its operation, and that of the plasmas produced in it, results of preliminary attempts at extraction and characterization of a beam are presented.

23093 Pseudospark as an electron beam source. Boggasch, E. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research); Rhee, M.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The pseudospark discharge phenomenon with interesting charged particle emission characteristics was introduced in 1978. This discharge utilizes the breakdown characteristics of the lower pressure side of the Paschen curve in a single or multigap parallel plate electrode geometry. To investigate the electron beam produced, the authors have constructed a modular type multigap pseudospark chamber. By using radiachromic film which gives a linear response up to an absorbed dose of 18^8 rad, the spatial profile of the beam was determined. At an axial distance of 3cm from the anode a beam diameter of 1.5 mm FWHM was found. Measurements of the beam emittance using an emittance meter consisting of slits and radiachromic film is presently underway and preliminary results are presented.

23094 Plasma diagnosis in the IGNITEX experiment. Booth, W.D. (Texas Univ., Austin, TX (USA)); Bickerton, R.; Carrera, R.; Hallock, G. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The plasma diagnostics for the proposed ignition experiment IGNITEX are presented. The IGNITEX device will be a compact (major radius = 1.5 m, minor radius = 0.5 m, elongation = 1.6) ohmically heated tokamak. The objective of the IGNITEX project is to produce an ignited D-T plasma for scientific study in a cost effective way. To produce ignited plasmas at low cost (i.e. in a compact ohmically heated tokamak) it is necessary to use very high (20 T) toroidal magnetic fields. This high field will be provided by a single-turn copper coil which completely encloses the plasma vessel. The complete covering of the vacuum vessel by the coils along with their single-turn construction limits access to the plasma for diagnostics.

23095 Relativistic magnetron research. Chen, S.C. (MIT, Cambridge, MA (US)); Bekefi, G.; Temkin, R.J. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 5B9.

The possibility of phase locking of relativistic magnetrons using low power injection signals is studied. The initial long pulse (0.2-1 μs) experiment showed the importance of voltage regulation for single-mode and stable frequency operation, the excitation of modes other than the dominating mode due to excessive voltage variation was observed with in one pulse as well as on shot-to-shot bases. It is found that voltage ripples on the order of 5% directly affect the output power stability. In addition, the experiment also indicated the possibility of using velvet as the cathode material for achieving long microwave pulses. Preliminary results of a long pulse, high repetition rate (1 μs, 4 pps) highly stable magnetron system (700 kV, 770 A) are presented.

23096 Interferometry techniques on fusion plasmas. Peebles, W.A. (California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research). pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

Optical interferometry techniques allow phase changes in a medium to be accurately determined. Since plasmas introduce modification proportional to electron density, interferometry has been used routinely to determine the time development of electron density profiles in magnetic confinement fusion plasmas. The present paper describes the basic principles of interferometry of plasmas and establishes criteria regarding wavelength selection, vibrational phase noise, phase averaging etc. In addition, recent advances in interferometry of fusion plasmas are described. For example, high spatial sampling has allowed the detailed study of MHD phenomena such as sawteeth and Mimov oscillations and 2-D imaging interferometry has permitted tomographic reconstruction of electron density contours. Difficulties associated with interferometry on future fusion devices, such as CIT are discussed together with possible solutions.

23097 Fast-probe plasma diagnostics. Manos, D.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Kilpatrick, S.J. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

The authors have used a variety of electrostatic, calorimetric and sample exposure probes to diagnose the edge plasma of neutral-beam heated discharges on the tokamak fusion test reactor (TFTR). In the past, spatial profiles of electron density and temperature, and other edge parameters, were generated by repositioning probes between discharges during experiments consisting of a large number of nominally identical discharges. Recently, they have employed a probe which executes a relatively rapid stroke to generate spatial and temporal profiles during a single discharge. This has greatly enhanced our ability to perform systematic studies of the edge plasma as various operating variables are changed. In addition, this rapid radial motion permits withdrawal of the probe during portions of the discharge when the intense neutral beam heating would otherwise damage the measuring tips. Applications of such a technique to low temperature, process plasmas are discussed.

23098 Optical imaging diagnostics for fusion plasmas. Allen, S.L. (Lawrence Livermore National Lab., CA (USA)). pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

Imaging diagnostics are used for spatially - and temporally - resolved quantitative measurements of plasma properties such as the ionization particle source, particle and energy loss, and impurity radiation in magnetically confined fusion plasmas. Diagnostics equipped with multi-element solid-state detectors (often with image intensifiers) are well suited to the environment of large fusion machines with high magnetic fields and x-ray and neutron fluxes. The authors have used both conventional (16 ms/frame) and high-speed video cameras to measure neutral deuterium H_α (6563 A) emissions from fusion plasmas. Continuous high-speed measurements are made with video cameras operating at 0.1-0.5 ms/frame; gated cameras provide snapshots of 10-100 μs during each 16-ms video frame. Digital data acquisition and absolute intensity calibrations of the cameras enable detailed quantitative source measurements; these are extremely important in determining the particle balance of the plasma. In a linear confinement device, radial transport can be determined from the total particle balance. In a toroidal confinement device, the details of a particle recycling can be determined. Optical imaging in other regions of the spectrum are also important, particularly for the divertor region of large tokamaks. Absolutely calibrated infrared cameras have been used to image the temperature changes in the walls and thereby determine the heat flux. Absolutely calibrated imaging ultraviolet spectrometers measure impurity concentrations; both spatial and spectral imaging instruments are employed. Representative data from each of these diagnostic systems is presented.

23099 A microwave interferometer for density measurement and stabilization in process plasmas. Pearson, D.I.C. (California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research); Campbell, G.A.; Domier, C.W.; Efthimion, P.C. pp. 322 of

Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

A low-cost heterodyne microwave interferometer system capable of measuring and/or controlling the plasma density over a dynamic range covering two orders of magnitude is demonstrated. The microwave frequency is chosen to match the size and density of plasma to be monitored. Large amplitude, high frequency fluctuations can be quantitatively followed and the longer-time-scale density can be held constant over hours of operation, for example during an inline production process to maintain uniformity and stoichiometry of films. A linear relationship is shown between plasma density and discharge current in a specific plasma device. This simple relationship makes control of the plasma straightforward using the interferometer as a density monitor. Other plasma processes could equally well benefit from such density control capability. By combining the interferometer measurement with diagnostics such as probes or optical spectroscopy, the total density profile and the constituent proportions of the various species in the plasma could be determined.

23100 **Generation and application of ultrafast x-ray sources.** Murnane, M.M. (California Univ., Berkeley, CA (USA). Dept. of Physics); Kapteyn, H.C.; Falcone, R.W. *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics (USA)*, 25(12): 2417-2422 (Dec 1989).

Pulses at soft X-ray wavelengths with a duration of less than 1.5 ps were produced by focussing high-intensity, ultrafast visible laser pulses onto a solid. Reflectivity measurements indicate that the laser pulses are absorbed by a plasma formed just inside the surface of the solid before expansion occurs. The observed emission spectrum is characteristic of a high-temperature, short-lived, high-density plasma. Applications of the ultrafast X-ray pulses, including an X-ray laser scheme, are discussed.

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Refer also to citation(s) 21570, 22148, 22336, 22337, 22338, 22341, 22342, 22373, 22403, 22405, 22408, 22409, 22842, 22878, 22990, 23005, 23022, 23023, 23075, 23076, 23078, 23079, 23080, 23081, 23082, 23084, 23086, 23087, 23089, 23090, 23091, 23092, 23093, 23094, 23238

23101 (CEA-CONF–9451) **System study methodology. Development and potential utilization for fusion.** Djerassi, H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Inst. de Protection et de Surete Nucleaire); Rouillard, J.; Leger, D.; Sarto, S.; Zappellini, G.; Gambi, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire. 1988. 13p. (CONF-880417–: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). Order Number DE90756404. Available from NTIS (US Sales Only), PC A03/MF A01.

The objective of this new methodology is to combine systemics with heuristics for engineering applications. The system method considers as a whole a set of dynamically interacting elements, organized for tasks. Heuristics tries to explicit the rules to apply in scientific research. This methodology is a powerful tool to evaluate the options to be made, compared with conventional analytical methods as a higher number of parameters can be taken into account, with higher quality standard while comparing the possible options. The system method takes into account interacting data or random relationships, by means of simulation modelling. Thus, a dynamical approach can be deduced and a sensitivity analysis can be performed for a very high number of options and basic data. Experimental values collection, analysis of the problem, search of solutions, sizing of the installation from defined functions, cost evaluation (planning and operating) and ranking of the options as regard all the constraints are the main points considered for the system's application. This method can be limited to a specific objective such as a fusion reactor safety analysis. The possibility of taking into account all the options, possible accidents, quality assurance, exhaustivity of the safety analysis, identification of the residual risk and modelisation of the results are the main advantages of this approach. The sophisticated architecture of a fusion reactor includes a large number of interacting systems. The new character of the fusion domain and the wide spectrum of the possible options strongly increase the advantages of a system study as a complete safety analysis can be defined before starting with the design.

23102 (CEA-CONF–9452) **System study application to the safety analysis of the exhaust and the tritium systems of a fusion reactor.** Djerassi, H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Inst. de Protection et de Surete Nucleaire); Rouillard, J.; Leger, D.; Sarto, S.; Zappellini, G.; Gambi, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire. 1988. 23p. (CONF-880417–: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). Order Number DE90756452. Available from NTIS (US Sales Only), PC A03/MF A01.

An applicative example of the general methodology system study to the safety analysis of the exhaust and tritium systems, in a tokamak device, is shown. The framework of the study is split into the following tasks: initial information collection, functional analysis, failure scenarios identification and description, reliability data assessment, accident sequence quantification, consequence seriousness evaluation, risk assessment. Results concerning risk contribution from direct failures show that, in the exhaust system and in the tritium system, the risk contribution to public is rather smaller than the safety design targets. Nevertheless, if the reactor building is not taken into account, the risk contribution from the exhaust system can be significant. Risk contribution to the workers seems to be not to heavy.

23103 (CEA-CONF–9482) **Investigation of γ lithium aluminate as tritium breeding material for a fusion reactor blanket.** Charpin, J.; Botter, F.; Briec, M.; Rasneur, B.; Roth, E.; Roux, N.; Sannier, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI). 1988. 13p. (CONF-880417–: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). Order Number DE90756451. Available from NTIS (US Sales Only), PC A03/MF A01.

The assessment of $\gamma LiAlO_2$, a potential ceramic breeder, is in progress at CEA, within the frame of the EEC fusion technology program. The performance of this material with respect to relevant issues is being investigated i.e fabrication, unirradiated material properties, neutron irradiation damage and tritium extraction. Using the selected fabrication route, pure and homogeneous materials are obtained covering a wide range of microstructures. Optimization of material microstructure with respect to tritium release is underway and upscaling of the fabrication capacity is being considered. Investigation of properties - physico-chemical, mechanical, thermal, compatibility with structural materials and beryllium - is underway and data, needed for design purposes, are being collected. Experiments were designed to investigate the neutron irradiation and the tritium release behaviours of the material. For aluminate pellets investigated so far in the 450^0C - 600^0C range, presented results show that neutron radiation damage is negligible and that tritium residence time may be less than one day.

23104 (CEA-CONF–9483) **Preliminary study of a blanket handling device and evaluation of the feasibility of eliminating the spread of radioactive contamination.** Leger, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)); Djerassi, H.; Maupou, M.; Charruyer, P.; Salpietro, E. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI). 1988. 12p. (CONF-880417–: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). Order Number DE90756450. Available from NTIS (US Sales Only), PC A03/MF A01.

A study concerning progress and future development of the BLANKET HANDLING DEVICE of NET-DN tokamak and the related potentialities against contamination dispersal during handling of internal segments. To prevent the dust dispersion during the mantainance operations, there are three options: a Tight-Intermediate Containment (TIC), a Containment Transfer Unit (CTU) or the dust fixation on the internal components. The design of the BHD takes account of multivarious dimensioning requirements (geometrical and dimensional constraints, including characteristics of the segments and torus), environmental and operational constraints (safety, lifetime, maintainability, cooling of Blanket segments, containment). The possible solutions concerning protection of special devices, during handling and travelling, are discussed.

23105 (CLM-R–293) **Concentrations of radiologically-important tramp elements in standard-grade stainless steels with particular relevance to activation of the first wall of NET.** Butterworth, G.J. UKAEA Culham Lab., Abingdon (UK). Jul 1989. 22p. Available from H.M. Stationery Office, London, price Pound 8.00. Available from H.M. Stationery Office, London, price Pound 8.00.

The dose equivalent rate of activated components determines the optimum time for decommissioning and the procedures adopted for the management of radioactive structural wastes from nuclear reactors. In standard-grade stainless steels the elements cobalt, nickel, niobium, molybdenum, silver and possibly some rare earth metals are the only ones likely to contribute appreciably to the γ dose rate at a cooling time around 100y. Up to about 80y after shutdown, ^{60}Co generated from iron, nickel and cobalt dominates the dose rate whilst at longer times ^{94}Nb from niobium and molybdenum and ^{108m}Ag from silver present as an impurity usually become dominant. Activation calculations have been performed for the irradiation regime anticipated for the first wall of the Next European Torus, in order to determine the concentration limits on cobalt, niobium and silver in a type 316L steel such that these potential impurity elements do not appreciably enhance the overall dose rate of the steel. A review of existing information on the impurity contents of stainless steels indicates that it should not be difficult to attain the required limits in a nuclear-grade 316L steel. (author).

23106 (CONF-891007–118) **Results from recent hydrogen pellet acceleration studies with a 2-m railgun.** Kim, K.; Zhang, D.J.; King, T.; Haywood, R.; Manns, W.; Venneri, F. Illinois Univ., Urbana, IL (USA). Fusion Technology Lab. Dec 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER52111. From 13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989. Order Number DE90008773. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new 3.2-mm-diameter, two-stage, fuseless, plasma-arc-driven electromagnetic railgun has been designed, constructed, and successfully operated to achieve a record velocity of 2.67 km/s(b) for 3.2 mmD x 4 mmL solid hydrogen pellet. The first stage of this hydrogen pellet injector is a combination of a hydrogen pellet generator and a gas fun. The second stage is a 2-m-long railgun which serves as a booster accelerator. The gas fun accelerates a frozen hydrogen pellet to a medium velocity and injects it into the railgun through a perforated coupling piece, which also serves a pressure-relieving mechanism. An electrical breakdown of the propellant gas, which has followed the pellet from the gas fun into the railgun, forms a conducting plasma-arc armature immediately behind the pellet allowing for fuseless operation of the railgun. Study of the pressure profile and the behavior of the plasma-arc armature inside the railgun bore led to elimination of spurious arcing, which prevents operation of the railgun at high voltages (and, therefore, at high currents). A timing circuit that can automatically measure the pellet input velocity and allows for accurate control of arc initiation behind the pellet helps prevent pellet disintegration and mistriggering of the arc initiation circuit. Results from the recent cryogenic operation of the two-stage pellet acceleration system are reported. 11 refs., 2 figs., 1 tab.

23107 (CONF-891204–21) **ITER [International Thermonuclear Experimental Reactor] R and D breeder blanket materials.** Smith, D.L. (Argonne National Lab., IL (USA)); Daenner, W.; Kalinin, G.; Yoshida, H. Argonne National Lab., IL (USA). Dec 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989. Order Number DE90007807. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The International Thermonuclear Experimental Reactor (ITER) activity includes specific R & D in critical areas to support the ITER design. Several of the critical tasks defined as part of the ITER validating R & D are materials related. This paper presents a summary of the breeder/blanket materials related R & D conducted by the four participating parties; viz., European Community, Japan, Soviet Union and the United States. The current effort includes several subtasks in each of the following four task areas: ceramic breeder materials; lead-lithium breeder; aqueous salt solutions; and neutron multiplier materials. The objective and scope of each subtask is states. Although this work was initiated in late 1988, important results have been obtained in all four areas. The work on ceramic breeders includes properties measurements, compatibility studies, and tritium recovery experiments with Li_2O and selected ternary ceramics. Investigations on the lead-lithium breeder have focused primarily on properties, compatibility, and tritium extraction from the 17Li-83Pb eutectic alloy. The work on the aqueous salt breeders includes corrosion, solution chemistry, and radiolysis effects in a radiation environment. Investigations defined under the neutron multiplier task are focused on beryllium; however, lead in the lithium lead alloy also serves as a neutron multiplier. The schedule and planned future work in each area are summarized. 1 refs., 6 tabs.

23108 (DOE/ER–0313/7) **Fusion reactor materials semiannual progress report for the period ending September 30, 1989.** Oak Ridge National Lab., TN (USA). [1989]. 315p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008083. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This is the seventh in a series of semiannual technical progress reports on fusion reactor materials. This report combines research and development activities which were previously reported separately in the following technical progress reports: alloy development for irradiation performance, damage analysis and fundamental studies, and special purpose materials. These activities are concerned principally with the effects of the neutronic and chemical environment on the properties and performance of reactor materials; together they form one element of the overall materials program being conducted in support of the Magnetic Fusion Energy Program of the US Department of Energy. The other major element of the program is concerned with the interactions between reactor materials and the plasma and is reported separately. The Fusion Reactor Materials Program is a national effort involving several national laboratories, universities, and industries. The purpose of this series of reports is to provide a working technical record for the use of the program participants, and to provide a means of communicating the efforts of materials scientists to the rest of the fusion community, both nationally and worldwide.

23109 (DOE/ER/52111–T6) **Application of railgun principle to high-velocity hydrogen pellet injection for magnetic fusion reactor refueling: Technical progress report.** Kim, Kyekyoon. Illinois Univ., Urbana, IL (USA). Dept. of Electrical and Computer Engineering. Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER52111. (FCPRL–8903). Order Number DE90008281. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report briefly discusses the research effort on using railgun accelerators to injection hydrogen fuel pellets in magnetically confined plasmas. (LSP)

23110 (DOE/ER/52158–1) **[Design of D-^{3}He commercial tokamak].** Kulcinski, G.L. Wisconsin Univ., Madison, WI (USA). Dept. of Nuclear Engineering and Engineering Physics. 1989. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER52158. Order Number DE90008252. Available from NTIS, PC A03/MF A01 - OSTI.

The Fusion Technology Institute of the University of Wisconsin is participating in the ARIES design study; the work during the present contract period, February 1, 1989 to October 31, 1989, is the first part of a two year project. The objective of this work has been to

contribute to the design of a D-^{3}He fueled commercial tokamak fusion reactor, ARIES II. In this proposal we summarize the work during the first phase and outline our plans for the second phase.

23111 (IAEA-TECDOC–536, pp. 75-81) **Engineering issues for plasma facing components of ITER.** Kuroda, T. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). ITER Nuclear Engineering Group). International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This paper is devoted to some critical aspects of the plasma facing components of the International Thermonuclear Experimental Reactor (ITER). The specific problems of plasma facing armour material, design features, divertor plates, etc. are emphasized. The high peak power loads present a difficult engineering problem. Carbon-based materials are capable of withstanding high heat loads without melting and have less effects as an impurity into the plasma. (author). 2 refs, 6 figs, 2 tabs.

23112 (IAEA-TECDOC–536, pp. 153-158) **Performance of JT-60 first wall.** Ando, T. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Takatsu, H.; Nakamura, H.; Yamamoto, M.; Kodama, K.; Fukaya, K.; Shimizu, M. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This paper describes material behaviors of the JT-60 divertor plates in outside and lower X-point operations performed to date with an absorbed energy up to 100 MJ/discharge. In the outside X-point operation, although heavy melting was observed at the edges of TiC-coated Mo divertor plates, bursts of Mo were suppressed by sweeping of the separatrix during neutral beam heating. About 30% of the graphite divertor tiles were broken in the outside X-point operation, while most of the graphite tiles survived in the lower X-point operation. Two different types of redeposition layers were observed on the graphite divertor tiles. Damages due to disruptions were observed on the electron-drift side of the lower divertor tiles. (author). 9 refs, 5 figs, 1 tab.

23113 (INIS-mf–11550) **Negative ion sourcery.** Os, C.F.A. van. Rijksuniversiteit Utrecht (Netherlands). 24 May 1989. 104p. Order Number DE90706042. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The work described in this thesis involved by current research programs in the field of nuclear-fusion. A brief introduction to fusion is given, anticipated problems related to current drive of the fusion plasma are pinpointed and probable suggestions to overcome these problem are described. One probable means for current drive is highlight: Neutral Beam Injection (NBI). This is based on injecting a 1 MeV neutral hydrogen or deuterium beam into a fusion plasma. Negative ions are needed as primary particles because they can easily be neutralized at 1 MeV. The two current schemes for production of negative ions are described, volume production and negative surface ionization. The latter method is extensively studied in this thesis. 171 refs., 55 figs., 7 tabs.

23114 (IPP–2/302, pp. 61-64) **W VII-X engineering.** Sapper, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The size and the performance data of the planned experimental W VII-X device require investigations to determine whether the technical solution should be a machine with either a superconducting coil set or with a 'classical' watercooled, pulsed copper coil magnet system. While the design and the cost of a normalconducting machine can be derived from the specific cost of W VII-AS, the design, schedule, and cost of a superconducting machine have to be investigated with the help of study contracts placed with industry because the number of existing and representative superconducting fusion devices is too small for a practical and direct calculation basis. Therefore, the IPP has placed two study contracts with industry, aiming at providing realistic information about the problems of a superconducting magnet system, cryostat and refrigerator plant. In the following, first comprehensive results obtained from these studies are reported. (orig.).

23115 (IPP–2/302, pp. 65-73) **Coil studies for Helias configurations.** Merkel, P. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The NESCOIL code for determining coils has been applied to the optimized Helias50B configuration. A solution with excellent accuracy is obtained by solving the boundary value problem with surface currents. A set of dense flux surfaces is shown. The value of iota on axis is ι=0.836 and at the edge ι=0.99. Realizations of the Helias50B vacuum field with 10 and 12 current filaments per period are presented for two slightly different coil systems (case 996 and cas 98B). (orig./AH).

23116 (IPP–2/302, pp. 74-85) **Parameter variations for W VII-X vacuum fields.** Kisslinger, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

For experimental flexibility, some variations of the vacuum field parameters are required, e.g. rotational transform, shear and magnetic axis position. Different possibilities are investigated and results for the configurations HS 4-12 and HS 5-8 are given. (orig.).

23117 (IPP–2/302, pp. 86-97) **Forces and stresses Helias coil systems.** Harmeyer, E. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Numerical calculations of the distribution of magnetic forces and mechanical stresses are mainly concentrated on the 5-period configuration HS 5-8. The calculations of the magnetic forces are performed with the EFFI code. Mechanical stresses and strains are computed with the SAPV (2) and ADINA programme systems. (orig.).

23118 (IPP–2/302, pp. 98-102) **On separation in mechanical behaviour of non-planar coil systems.** Jaksic, N.; Jandl, O.; Simon-Weidner, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The interest is focussed on calculations to studies of the W VII-AS and W VII-X performed by a small team of engineers. The actual investigations are belonging to the following points: (1) Examination of calculations with regard to separation effects of coil 3 (W VII-AS). (2) Investigations of separation effects on the mechanical behaviour of non-planar coil systems to get familiar with possible candidates for W VII-X. The actual state of these calculations and some of the considerations in this context will be presented here. (orig.).

23119 (IPP–2/302, pp. 103-105) **Engineering status of the W VII-AS coil system.** Sapper, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany,

F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The confinement coil system of the W VII-AS experiment was finally assembled in May 1988. After a period of field mapping operation and an additional assembly phase for the completion of the experimental equipment, the machine went into plasma operation in October the same year. Following an initial experimental period with an axis induction of B_0=1.25 T (which is half of the value calculated for fundamental resonance with ECRH, 70 GHz) the machine was used for regular operation with B_0=2.5 T in January 1989. An unexpected amount of movement at modular field coils of type No. 3 and a beginning damaging effect in the winding pack compound of that coil urged the users to limit the induction to B_0 = 1.6 T for further operation. In the following, a summary of the predicted coil performance, the measured data, and the work intended for improvement of the coil system is given. (orig.).

23120 (IPP–2/302, pp. 106-110) **On normal-conducting versions for W VII-X.** Harmeyer, T. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Normal-conducting modular coils have been built already and are successfully in use on W VII-AS. Based on feasibility studies made by industry, it is believed that extending this technique to larger experiments does not present insurmountable difficulties. For comparison with the superconducting option, a normal-conducting version has been designed which shows the limitations and restrictions of this alternative. These limitations are consequences of the large ohmic power dissipated in the coils and the available electrical energy. The temperature rise in the coils limits the flat-top time of the magnetic field. (orig.).

23121 (IPP–2/302, pp. 111-114) **Tests for superconducting W VII-X coils (short samples, small test coil, prototype coil with KfK-LCT coil).** Maurer, W. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Technische Physik). Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The base of the following considerations is the stellarator configuration HS 58 A. It has 6 different coil geometries. Coil No. 5 is considered to be built as prototype for testing all principles necessary to be investigated before the final construction of W VII-X superconducting coils. The logical sequence to reach this goal is the development and testing of short lengths of the conductor, followed by the test of a subsize solenoidal coil constructed out of a full fabrication length of the conductor, then finished by the test of a prototype coil. (orig.).

23122 (IPP–2/302, pp. 115-122) **On edge fields and limiter/wall loads in HS5-8.** Rau, F.; Kisslinger, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Properties of edge vacuum fields are studied for three values of the rotational transform τ for the vacuum magnetic fields of HS 5-8, a Helias configuration with major radius R_0=6.5 m and aspect ratio A $\simeq$ 10, by observing the intersection points of field lines or guiding center orbits with the first wall or with a tentative limiter system. (orig.).

23123 (IPP–2/302, pp. 127-130) **Island formation in stellarators.** Wobig, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Island formation in stellarators may have several reasons: Inherent lack of symmetry in the vacuum field (helical symmetry, axisymmetry), symmetry breaking external perturbation of the vacuum field, equilibrium currents in the plasma, plasma instabilities. (orig.).

23124 (IPP–2/302, pp. 131-138) **On the reduction of magnetic islands, residues in HS 5-7.** Herrnegger, F. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

A systematic method is applied to reduce the size of magnetic islands in vacuum field configurations where the magnetic fields are given by a set of Dommaschk potentials of low order. In typical cases, fields with 3, 5, 10, 12 toroidal field periods and poloidal mode numbers up to 4 (including axisymmetric fields) define a last closed magnetic surface with aspect ratio A $\simeq$ 11 to 13 and rotational transfor τ_b=5/7 near the boundary. Cross sections of magnetic surfaces are plotted at 0, L_p/4, L_p/2 of a field period. (orig.).

23125 (IPP–2/302, pp. 139-147) **On natural magnetic islands and external perturbations in Helias vacuum fields.** Rau, F. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Properties of magnetic islands are studied for vacuum fields of some Helias configurations which are generated by sets of modular coils. Three Helias configurations named 'Kyoto'-Helias, HS 5-7 and HS 5-8 are compared. They have 5 field periods and are adjusted for values of the rotational transform τ=1 near the edge. The configurations otherwise differ mainly in the amount of shear and the relative position of the resonant surface. (orig.).

23126 (IPP–2/302, pp. 186-188) **Neutral injection into Wendelstein VII-X.** Penningsfeld, F.P.; Speth, E. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

The present concept for Neutral Injection into W VII-X is being presented and its main characteristics are being described. The present concept is identical with the ASDEX Upgrade neutral injection concept, which delivers 6 MW per box for 55 kV hydrogen order 9 MW per box for 65 kV deuterium. Recent developments for the second injector on ASDEX Upgrade have led to a 100 kV deuterium version, which should deliver around 7 MW per box. The main advantage for W VII-X would be that for 100 kV deuterium only about 10^{21} particles sec^{-1} are delivered by neutral injection at a power of 14 MW. The injction geometry has been determined to be at an angle of 20^0 with respect to normal at the location $\Phi=0^0$ and an elevation of about 14 cm above the midplane (for co-injection). Deposition profiles have been calculated for the 3 different scenarios (55 keV H^0, 65 keV D^0, 100 keV D^0), showing that 65 keV D^0 is optimum in the sense of central heating power density and minimum shine through. A lower operational density limit, given by the maximum permissible wall load on the carbon tiles is between 6 and $8x10^{13}$ cm^{-3}. The fraction of the starting ions which are toroidally trapped depends strongly on the injection angle and assumes values of about 10% for the envisaged injection angle of 20^0. (orig./AH).

23127 (IPP–2/302, pp. 189-197) **NBI-heating of W7X using ASDEX-upgrade type NI-boxes.** Penningsfeld, F.P. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. (CONF-8906301–: 3. workshop on Wendelstein VII-X, Schloss Ringberg (Germany, F.R.), 26-30 Jun 1989). In *Proceedings of the 3rd workshop on Wendelstein VII-X.* Order Number DE90759669. Available from NTIS (US Sales Only), PC A10/MF A01.

Introduction: (List of first questions, W7X as NBI target); NBI-Geometry (Box and duct; beam/plasma position for $\gamma_{NI}=20^0$); Absorption of the neutral input power (H^0/55 keV/6 MW per box; D^0/65 keV/9 MW per box; D^0/100 keV/7 MW per box; Discussion of the power density profiles); Pitch angle of fast ions (global distributions; radial resolved distribution); Shinethrough losses (Transmitted power profile; lower operational limit for the target density); Conclusions. (orig.).

23128 (IPP–4/237) **Beam heating of the neutralizer gas of neutral beam injectors.** Ott, W. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Feb 1989. 37p. Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.).

It was shown by Pamela that the target thickness of the neutralizer gas in neutral beam injectors is smaller than to be expected from gas flow calculations. He explained his findings by direct and indirect beam heating of the gas and a consequent flow acceleration. The role of the neutralizer plasma electrons in the gas heating scenario is reconsidered here. To this end the particle and energy balances of the electrons are solved with allowance for ionization and dissociation of the gas by the electrons. It is shown that the direct contribution of the electrons to heating is not dominant. Their indirect contribution via ion acceleration in the space charge sheath in front of the walls is usually stronger. Methods to increase the neutralizer target thickness are investigated. They are essentially (1) structuring the neutralizer surface in order to reduce the reflection of medium energy particles and to increase the gas accommodation, (2) cooling down the neutralizer to LN_2-temperature. The scaling of the target thickness with various parameters is investigated and compared with 'cold' flow. Initially it was assumed that the neutralizer plasma electrons are hot and able to excite Balmer alpha radiation in collisions with H_2 molecules. The investigation shows that the electrons must be cold instead ($T_e<5$ eV). An enhanced emission of the unshifted Balmer alpha line as measured on the IPP test bed is probably caused by dissociative recombination of H^+_2 and H^+_3 ions leading to excited hydrogen atoms. (orig.).

23129 (IPP–4/238) **Report on the low-RF-power and data-acquisition-systems of the 2.45 GHz Lower-Hybrid Transmitter at the ASDEX tokamak.** Zouhar, M.; Monaco, F. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Mar 1989. 52p. Order Number DE90759698. Available from NTIS (US Sales Only), PC A04/MF A01.

This report relates to the low-power section of the 2.45 GHz transmitter used for current drive experiments at the ASDEX tokamak. The high-RF-power section is dealt with elsewhere. Data acquisition and evaluation of quantities pertaining to the Lower Hybrid experiment are also treated here. As in the previous report on the 1.3 GHz system (M. Zouhar: 'Beschreibung des Niederleistungsteils des HF-Systems fuer die LH-Experimente in ASDEX.', IPP-report 4/218, February 1984), most space is spent in commenting upon the amplitude (power)- and phase-feedback control loops. (orig.).

23130 (JAERI-M–89-166) **Interpretation and handling manual of fusion experimental data monitor system DAISY version 1.** Tani, Keiji (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kihara, Kazuhisa; Haginoya, Hirofumi. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 87p. (In Japanese). Order Number DE90759890. Available from NTIS (US Sales Only), PC A05/MF A01.

We have developed a new soft program 'DAISY' to monitor fusion experimental data on graphic terminals. Users of 'DAISY' are free from the troublesome work to access data base and to lean computer graphic language, and can interactively display their abjective data with easy keyboard handling. 'DAISY' provides many display patterns, quick control of display figures and easy handling of plot data. This report summarizes a brief interpretation and the usage of 'DAISY'. (author).

23131 (JET-R–89-14) **A comparison between beryllium and graphite as materials for JET limiters and wall surfaces.** Hugon, M.; Lallia, P.P.; Rebut, P.H. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. 1989. 22p. Order Number DE90618841. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

JET has always been operated with graphite limiters. Carbonisation has been performed from time to time resulting in a temporary reduction of Z_{eff}. However, the latest results at high power (up to 30 MW) indicate that in most cases the impurity content in the plasma is too large to reach near reactor conditions. To reduce the impurity content to a level acceptable in a reactor, it is proposed to use beryllium as a material for the limiters and wall surfaces in JET. This proposal was first made four years ago on the basis of a report comparing the relative merits of beryllium and carbon. This report is now updated in the present paper, which contains three parts, covering the effects of impurities on the plasma performance, the physical and chemical properties of graphite and beryllium and a simple model for the impurity production at the plasma edge. (author).

23132 (LA-UR–89-4110) **Amplified spontaneous emission measurements on the aurora large-aperture module.** Oertel, J.A.; Czuchlewski, S.J.; Leland, W.T.; Turner, T.P. Los Alamos National Lab., NM (USA). 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900530–1: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90004841. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Amplified Spontaneous Emission is measured on the large-aperture module ($1 \times 1 \times 2$ m^3) of the Aurora KrF laser. Values are compared to the predictions of a 3-D code. 2 refs., 1 fig.

23133 (LBL–28264) **Heavy Ion Fusion Accelerator Research (HIFAR) year-end report, April 1, 1989–September 30, 1989.** Lawrence Berkeley Lab., CA (USA). Dec 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (HIFAN–442). Order Number DE90008068. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report contains the following topics on heavy ion fusion: MBE-4 drifting beam quadrupole operating range; transverse emittance growth in MBE-4; an improved ion source for MBE-4; drifting beam studies on MBE-4; 2-MV injector; improvements in lifetime of the C^+ source; injector control system; Maxwell spark gap test update; ILSE cosine 2θ quadrupole magnet development; electrostatic quadrupole prototype development activity; induction accelerator cell development; effect of a spread in beamlet currents on longitudinal stability; and heavy ion linac driver analysis.

23134 (ORNL/ATD–28/V2) **An interim report on the materials and selection criteria analysis for the Compact Ignition Tokamak toroidal field coil turn-to-turn insulation system: Volume 2, Photographic summary of laboratory testing: Interim results.** Campbell, V.W.; Dooley, J.B.; Hubrig, J.G.; Janke, C.J.; McManamy, T.J.; Welch, D.E. Oak Ridge National Lab., TN (USA). Applied Technology Div. Jan 1990. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008020. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This document contains photographs showing the results of laboratory testing of the combinations of epoxy resins, hardeners, and cures undertaken as part of the Compact Ignition Tokamak Insulation Screening Program. Cryogenic shock and soak to equilibrium proved to be the most demanding condition for these materials. The degree of damage to the basic materials when a poor candidate is selected is shown to be quite dramatic. 34 figs.

23135 (ORNL/FEDC–89/4) **Equilibrium calculations for plasma control in CIT [Compact Ignition Tokamak].** Strickler, D.J. (Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center); Peng, Y-K.M.; Pomphrey, N.; Jardin, S.C. Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center. Jan 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008086. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The free-boundary equilibrium code VEQ provides equilibrium data that are used by the Tokamak Simulation Code (TSC) in design and analysis of the poloidal field (PF) system for the Compact

Ignition Tokamak (CIT). VEQ serves as an important design tool for locating the PF coils and defining coil current trajectories and control systems for TSC. In this report, VEQ and its role in the TSC analysis of the CIT PF system are described. Equilibrium and coil current calculations are discussed, an overview of the CIT PF system is presented, a set of reference equilibria for modeling a complete discharge in CIT is described, and the concept of a plasma shape control matrix is introduced. 9 refs., 8 figs., 7 tabs.

23136 (ORNL/FEDC–90/2) **NUFACE: An interface code for the calculation of nuclear responses.** Henderson, D.L. (Oak Ridge National Lab., TN (USA)); Gomes, I.C. Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center. Jan 1990. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008088. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The NUFACE interface code computes nuclear responses for use in the nuclear analysis of a given tokamak reactor design. The NUFACE code operates on the neutron and gamma fluxes provided by the one-dimensional neutral-particle transport code ONEDANT. Zonewise and zone-boundary responses are computed to obtain both zone-integrated values and maximum surface values. Information on each material mixture within a zone and on each element or isotope constituent of each material is computed. This feature allows for a detailed analysis of the reactor whereby one can easily identify the fractional contribution to the response of interest from each material and each element or isotope. 4 refs., 4 figs., 3 tabs.

23137 (ORNL/FTR–3541) **[Reactor shielding experiments and analysis]: Foreign trip report, February 10–16, 1990.** Santoro, R.T. Oak Ridge National Lab., TN (USA). 28 Feb 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008764. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the ITER Specialists Meeting on Shielding Experiments and Analysis at the ITER Facilities at the Max Planck Institute for Plasma Physics, Garching, FRG and presented a paper entitled "US Shielding and Streaming Experiments: A Brief Review." The purpose of the meeting was to reach a consensus among experts in the field on shielding and related experiments required to support the design and construction of the ITER. Experiments that have been performed to date in the US, Japan, USSR, and Europe were reviewed and the results were extensively discussed for their application to the ITER design. The requirements for additional experiments along with supporting analytic needs were reviewed. The conclusions of the meeting were summarized for inclusion in ITER requirements documents.

23138 (ORNL/FTR–3542) **[Thermonuclear experimental reactor workshop on materials and components]: Foreign trip report, January 27, 1990–February 14, 1990.** Davis, J.W. Oak Ridge National Lab., TN (USA). 1 Mar 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007642. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report summarizes the results of the Plasma Facing Components Workshop, and the Specialists' Meeting on ITER Materials Data Base which were held at the ITER Winter Session in Garching, FRG. In addition to the ITER meetings a visit was made to SEP, which produces a carbon-carbon called SEPCARB N1. This material is currently being evaluated for use in the bumper limiter of the CIT. This report describes the company, the products they produce, and their testing capability.

23139 (ORNL/TM–11420) **Particle transport in pellet fueled JET [Jet European Torus] plasmas.** Baylor, L.R. Oak Ridge National Lab., TN (USA). Jan 1990. 180p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008077. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

Pellet fueling experiments have been carried out on the Joint European Torus (JET) tokamak with a multi-pellet injector. The pellets are injected at speeds approaching 1400 m/s and penetrate deep into the JET plasma. Highly peaked electron density profiles are achieved when penetration of the pellets approaches or goes beyond the magnetic axis, and these peaked profiles persist for more than two seconds in ohmic discharges and over one second in ICRF heated discharges. In this dissertation, analysis of electron particle transport in multi-pellet fueled JET limiter plasmas under a variety of heating conditions is described. The analysis is carried out with a one and one-half dimensional radial particle transport code to model the experimental density evolution with various particle transport coefficients. These analyses are carried out in plasmas with ohmic heating, ICRF heating, and neural beam heating, in limiter configurations. Peaked density profile cases are generally characterized by diffusion coefficients with a central ($r/a < 0.5$) diffusivity ~ 0.1 m^2/s that increases rapidly to ~ 0.3 m^2/s at $r/a = 0.6$ and then increases out to the plasma edge as $(r/a)^2$. These discharges can be satisfactorily modeled without any anomalous convective (pinch) flux. 79 refs., 60 figs.

23140 (PNL-SA–15704) **Implications of neutron spectrum and flux defferences on fission-fusion correlations at high neutron fluence.** Garner, F.A. (Pacific Northwest Lab., Richland, WA (USA)); Heinisch, H.L.; Simons, R.L.; Mann, F.M. Pacific Northwest Lab., Richland, WA (USA). Mar 1988. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-880378–3: Workshop on the effects of recoil spectrum and nuclear transmutation on the evolution of the microstructure, Lugano (Switzerland), 24-29 Mar 1988). Order Number DE90008611. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The application to fusion environments of materials data derived from fission reactors involves considerations related not only to neutron spectra but also the often dominant effect of displacement rate. It is shown in this paper that fission-fusion correlation experiments directed toward helium effects and PKA recoil spectra are frequently difficult to interpret due to the strong influence of displacement rate, low energy recoils from thermal neutron absorption and in some cases a large influence of solid transmutants. It is also shown that materials data published in earlier decades must be reevaluated in light of recent advances in defining irradiation parameters. 58 refs., 23 figs., 1 tab.

23141 (PNL-SA–16984) **Neutron-induced changes in density and electrical conductivity of copper alloys at 16 to 98 dpa and 420°C.** Garner, F.A. (Pacific Northwest Lab., Richland, WA (USA)); Brager, H.R.; Anderson, K.R. Pacific Northwest Lab., Richland, WA (USA). [1989]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–22: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90008603. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An irradiation experiment on copper alloys in the Fast Flux Test Facility (FFTF) at 430°C has been completed. Four exposure levels were reached with the maximum at 98 dpa. Immersion density measurements of a wide variety of copper alloys show swelling values ranging from 1 to 64% at 98 dpa. Copper that is dispersion-strengthened with 0.25% Al_2O_3 (designated Al25) appears to be the most swelling resistant and promising high conductivity alloy. The steady-state swelling rate of relatively simple copper alloys was found to be ~ 0.5%/dpa at 430°C. Both the swelling and conductivity changes of the pure copper reference alloy were found to be very reproducible. 11 refs., 4 figs., 1 tab.

23142 (PNL-SA–16989) **Tensile behavior and swelling of ternary austenitic alloys irradiated in different neutron spectra.** Hamilton, M.L. (Pacific Northwest Lab., Richland, WA (USA)); Garner, F.A.; Okada, A. Pacific Northwest Lab., Richland, WA (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–23: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90008620. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two nominally identical experiments were designed to study the effects of nickel, chromium, cold work and helium generation rate on neutron-induced swelling and changes in tensile properties of simple Fe-Cr-Ni alloys. One was conducted in the Oak Ridge Research Reactor (ORR) at higher He/dpa ratios and lower displacement rates than the other, conducted in the Experimental Breeder Reactor II (EBR-II). The ORR results are at higher dpa levels and show substantially more strengthening and a different temperature range of swelling. 12 refs., 4 figs., 3 tabs.

23143 (PNL-SA-16990) **Irradiation creep and swelling of the fusion heats of PCA, HT9 and 9Cr-1Mo irradiated to high neutron fluence.** Garner, F.A.; Puigh, R.J. Pacific Northwest Lab., Richland, WA (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–25: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90008612. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The irradiation creep and swelling at 400–600°C of the fusion heats of PCA, HT9 and 9Cr–1Mo were studied using pressurized tubes irradiated in the Fast Flux Test Facility (FFTF). At ≤550°C the irradiation creep of all three alloys was found to be proportional to the stress level and the instantaneous swelling rate. Although swelling is sensitive to temperature, stress, alloy type, cold work and composition, the creep-swelling coupling coefficient does not appear to be very sensitive to these variables. 12 refs., 2 figs.

23144 (PNL-SA-16998) **Tritium release from irradiated beryllium at elevated temperatures.** Baldwin, D.L.; Slagle, O.D.; Gelles, D.S. Pacific Northwest Lab., Richland, WA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–24: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90008602. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Tritium release kinetics have been measured for neutron-irradiated beryllium in the temperature range of 573–884 K. Two tritium release tests of 270 and 550 hours are the first in a series of tritium release tests on irradiated Be in support of International Thermonuclear Experimental Reactor (ITER) blanket designs. Real-time tritium release curves were measured after temperature step changes of 100 K by an ionization chamber under conditions specific to ITER. The conditions and experiment were designed to measure diffusion-controlled release from irradiated Be. The preliminary conclusion from this data set is that a unique rate-controlling mechanism is not distinguishable. Apparent diffusion kinetics at lower temperatures give way to a burst release at 884 K, coincident with a restructuring and bubble coalescence in this fully dense material. 7 refs., 5 figs., 1 tab.

23145 (PPPL–2678) **The effect of prepulse on x-ray laser development using a powerful subpicosecond KrF- laser.** Nam, C.H.; Tighe, W.; Valeo, E.; Suckewer, S. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008003. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A high power uv laser has been developed as a pump source for short wavelength (down to 1 nm) x-ray lasers. Various schemes are considered and theoretical analysis is discussed. Spectroscopic studies of laser-target interaction have been performed and, in particular, the effect of a prepulse on plasma generation has been investigated. Analysis of the observed spectra indicates that reduction of the prepulse energy results in a higher temperature plasma. Investigation of the interaction using thin layered targets is also presented. These data provide evidence for initially hot plasma conditions generated from target layers ≤150 Å. Discussions of proposed laser schemes at 1-5 nm are presented. 45 refs., 8 figs., 1 tab.

23146 (Rijnhuizen-report–89-186) **FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.** NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. 53p. (CONF-8905159–:). Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report contains five contributions all being in INIS-scope, entitled respectivel: Measurements on Waveguide Components for ECRH on RTP; Electron Cyclotron Resonance heating on RTP; Electron Cyclotron Heating of High Density JET H-Mode Discharges; Electron Cyclotron Current Drive and m=2 Mode Stabilization in NET; A Double-heterodyne ECE Radiometer for the measurement of Small Temperature Fluctuations on RTP. (author). 37 refs.; 30 figs.; 5 tabs.

23147 (SAND–90-0746C) **Designing an experimenters database using the Nijssen Information Analysis Methodology (NIAM).** Eaton, M.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900580–2: 1990 Digital Equipment Corporation User's Society meeting, New Orleans, LA (USA), 7-11 May 1990). Order Number DE90008548. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper presents a discussion of the use of the Nijssen Information Analysis Methodology (NIAM) in the design of an experimenters database. This database is used by physicists and technicians to describe the configuration and diagnostic systems used on Sandia National Laboratories Particle Beam Fusion Accelerator II (PBFA II). The design of this database presented some unique challenges because of the large degree of flexibility required to enable timely response to changing experimental configurations. The NIAM user-oriented technique proved to be invaluable in translating experimenter's requirements into an information model and then to a normalized relational design.

23148 (UCID–21952) **Optimum detector distance for neutron TOF [time-of-flight] temperature measurements.** Lerche, R.A. Lawrence Livermore National Lab., CA (USA). 8 Dec 1989. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008059. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fuel ion temperatures for laser-driven, inertial-confinement fusion targets are often determined by neutron time-of-flight techniques. An optimum target-to-detector distance exists where the error in the temperature measurement is a minimum. Optimum distance depends on both target and detector characteristics. Equations are presented which relate the temperature error to the target ion temperature, the number of neutrons detected, and the detector temporal response. Sample calculations of temperature error and optimum detector distance for D-D and D-T plasmas are presented for typical Nova neutron time-of-flight detectors. They show that proper placement of a TOF detector is important for minimizing the temperature error for targets that have low neutron yields. For these detectors, temperature error becomes relatively insensitive to position for target yields above 10^{10} neutrons. Also, the analysis technique used to estimate signal broadening from recorded data is shown to be important for achieving statistically limited measurements. 2 refs., 11 figs., 5 tabs.

23149 (UCRL–98535) **Application of uncertainty analysis of ignition performance to the Engineering Test Reactor.** Ho, S.K.; Perkins, L.J. Lawrence Livermore National Lab., CA (USA). 16 Sep 1988. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-881031–78: 8. topical meeting on technology of fusion energy, Salt Lake City, UT (USA), 9-13 Oct 1988). Order Number DE90008310. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The design of future Engineering Test Reactor (ETR) to demonstrate ignition is complicated by the uncertainties in the projected database for ignited plasmas. Application of uncertainty analysis to ETR design utilizing a figure-of-merit defined as the probability of ignition is presented. Performance evaluation from the uncertainty analysis in density-temperature space can locate an optimum operating window for ignition. 11 refs., 5 figs., 3 tabs.

23150 (UCRL–98585) **Development of 3D simulations for heavy ion fusion beam transport and compression problems.** Mark, J. W.K. (Lawrence Livermore National Lab., CA (USA)); Friedman, A.; Chang, Chia-Lie; Drobot, A.; Mankofsky, A.; Faltens, A. Lawrence Livermore National Lab., CA (USA). Aug 1988. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8806101–12: International symposium on heavy ion inertial fusion, Darmstadt (Germany, F.R.), 28-30 Jun 1988). Order Number DE90008355. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Longitudinal beam compression and the possibility of concurrent pulse shaping have been the subject of previous studies using analytical methods and 1D and 2D codes. Here we report on a code development effort to study 3D beam transport in quadrupoles and final compression of a drifting heavy ion beam pulse. As part of

this effort we are making improvements to the ARGUS particle-in-cell (PIC) code to investigate 3D effects of magnetic quadrupole beam transport. A system with magnetic quadrupole focusing fields is realistically three dimensional. Although magnetic quadrupole are expected to be an integral part of much of the heavy ion accelerator driver, the restrictions due to space charge modifications of the beam are particularly acute during final compression and focus, and so we concentrate on this stage. Our initial preliminary benchmarking runs are presented.

23151 (UCRL–98768) **Magnetic reconnection simulation using the 2.5D em [electromagnetic] direct implicit code AVANTI.** Hewett, D.W.; Francis, G.E.; Max, C.E. Lawrence Berkeley Lab., CA (USA). 30 Aug 1988. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8809173–2: International workshop on reconnection in space plasma, Potsdam (German Democratic Republic), 5-9 Sep 1988). Order Number DE90008357. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Collisionless reconnection of magnetic field lines depends upon electron inertia effects and details of the electron and ion distribution functions, thus requiring a kinetic description of both. Though traditional explicit PIC techniques provide this description in principle, they are severely limited in parameters by time step constraints. This parameter regime has been expanded by using the recently constructed 2.5 D electromagnetic code AVANTI in this work. The code runs stably with arbitrarily large Δt and is quite robust with respect to large fluctuations occurring due to small numbers of particles per cell. We have found several qualitatively new features. The reconnection process is found to occur in distinct stages: early spontaneous reconnection fed by the free energy of an initial anisotropy in the electron component, coalescence of the resulting small-scale filaments of electron current, accompanied by electron jetting, and oscillatory flow of electrons through the magnetic X-point, superposed on continuing nonlinear growth of ion-mediated reconnection. The time evolution of stage is strongly dependent on M_i/m_e. 12 refs., 6 figs.

23152 (UCRL–98806) **Direct evidence of ponderomotive filamentation.** Young, P.E. (Lawrence Livermore National Lab., CA (USA)); Drake, R.P.; Campbell, E.M.; Estabrook, K.G.; Baldis, H.A. Lawrence Livermore National Lab., CA (USA). Sep 1988. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-881056–11: 19. European conference on laser interaction with matter (ECLIM), Madrid (Spain), 3-7 Oct 1988). Order Number DE90008367. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We present an experiment in which the ponderomotive filamentation instability is driven in a pre-formed, underdense plasma. The spatial profile of the driving beam is intentionally modulated to produce a striated intensity distribution of known periodicity. Dark-field imaging is used to observe the density perturbations produced by the instability. Ponderomotive filamentation is isolated from thermal filamentation by the plasma parameters and the intensity perturbation wavelength. The threshold intensity for perturbation wavelengths of 42 μm is approximately 3×10^{13} W/cm^2 which compares favorably with homogeneous instability theory. 6 refs., 4 figs.

23153 (UCRL–99094) **Ultra-high brightness laser research at LLNL [Lawrence Livermore National Laboratory].** Patterson, F.G.; Perry, M.D.; Campbell, E.M. Lawrence Livermore National Lab., CA (USA). Mar 1989. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890142–6: Symposium on lasers and optics, Los Angeles, CA (USA), 15-20 Jan 1989). Order Number DE90008366. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

New short-pulse laser technology has made possible the production of extremely bright (>10^{18} W/cm^2-sr) laser sources. The use of these new techniques on large scale Nd:glass based laser systems would make it possible to produce 1000 TW (Petawatt) pulses. Such pulses would yield focused intensities exceeding 10^{21} W/cm^2 corresponding to an electric field in excess of 100 e/a_0^2 and an energy density equivalent to that of a 10 keV blackbody. The first step towards the realization of such a source is the development of a compact 10 TW laser. The design of a 10 TW table-top laser and some potential applications are described. 12 refs., 5 figs.

23154 (UCRL–102536) **Improved energy and power balance at Nova targets.** Speck, D.R.; Bibeau, C.; Ehrlich, R.B.; Henesian, M.A.; Hermes, G.L.; Laumann, C.W.; Lawson, J.K.; Powell, H.T.; Murray, J.E.; Wegner, P.J. Lawrence Livermore National Lab., CA (USA). 7 Dec 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900530–5: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90007260. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Nova can now provide more than 40 kJ of energy and shaped laser pulses onto targets at 0.35 μm. We are improving the power balance at 0.35 μm as required for optimum target performance. 2 refs., 2 figs., 1 tab.

23155 (UCRL–102537) **Shaped pulses from Nova for inertial confinement fusion experiments.** Burkhart, S.C.; Padilla, E.H.; Weiland, T.L.; Wilcox, R.B. Lawrence Livermore National Lab., CA (USA). 7 Dec 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900530–6: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90007261. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Temporally shaping the target irradiation pulse is crucial for the realization of inertial confinement fusion. We have developed a versatile electrooptic technique for making shaped pulses at 0.35 μm on Nova. 4 refs., 3 figs.

23156 (UCRL–102907) **WARP: A 3D (+) PIC Code for HIF simulations.** Friedman, A. (Lawrence Livermore National Lab., CA (USA)); Callahan, D.A.; Grote, D.P.; Langdon, A.B.; Haber, I. Lawrence Livermore National Lab., CA (USA). 6 Feb 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900163–6: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90008368. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We describe WARP, a particle-in-cell code developed for heavy ion fusion accelerator studies. Along with a 3d (Cartesian) description, and r, z model, a 1d (axial) model, and an envelope calculation are being incorporated within the code. The self-field is assumed electrostatic in the beam frame; particle positions and momenta are time-advanced in the laboratory frame. We employ several non-standard techniques, including: an "isochronous" relativistic leapfrog mover, in which positions and velocities are advanced from one integer time level to the next. This facilitates particle loading and diagnostics, and a variable timestep size. Use of only two 3d field arrays (ρ and ϕ), differencing ϕ for each particle to get E; use of a single 3d array is feasible. "Residence corrections" to the applied fields from sharp-edged elements, to assure a constant impulse independent of the number of discrete steps on which a particle stops within each element. A test run which models a beam undergoing drift compression is presented. A new method for modeling bends, under development for WARP, is also described briefly. 10 refs., 8 figs., 1 tab.

23157 **Liquid metal magnetohydrodynamics.** Lielpeteris, J. 496p. Kluwer Academic Publishers, Norwell, MA (1989).

Liquid metal MHD is the subject of this book. It is of central importance in fields like metals processing, energy conversion, nuclear engineering (fast breeders or fusion reactors), geomagnetism and astrophysics. In some circumstances fluid flow phenomena are controlled by an existing magnetic field; the melts in induction furnaces or the liquid metal blanket around future tokamak fusion reactors being significant examples. In other cases the application of an external magnetic field (or of an electric current) may generate drastic modifications in the fluid motion and in the transfer rates; such effects may be used to develop new technologies (electromagnetic shaping) or to improve existing techniques (electromagnetic stirring in continuous casting). In the core of the Earth, fluid motion and magnetic fields are both present and their interaction governs important phenomena.

23158 Development of the BOLVAPS/LIBORS lithium ion source for the PBFA II accelerator. Dreike, P.L. (Sandia National Labs., Albuquerque, NM (USA)); Tisone, G.C.; Appel, D.B.; Gerstle, F.P.; Lamppa, K.P.; Mattox, D.M.; McCollister, H.L.; Moore, R.H.; Renk, T.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A mm thick, 10^{16} - 10^{17} cm^{-3} Li plasma may be the ion source for the PBFA II Applied-B ion diode. BOLVAPS (boil-off lithium vapor source) is a technique for making a thin layer of Li vapor by rapid ohmic heating of a thin-film laminate, one layer of which contains Li. LIBORS (laser ionization based on resonance saturation) is a technique for ionizing Li using light tuned to the 670.8 nm Li transition. The authors are fabricating and evaluating prototype BOLVAPS anodes using alumina and enameled substrates. In this paper, they describe the BOLVAPS/LIBORS scheme in detail, review its underlying physics, outline the major materials and electrical engineering challenges, and present the status of plasma source experiments.

23159 Steady-state, gas-filled orbitron maser. Rader, M. (The Univ. of Tennessee (USA)); Dyer, F.; Alexeff, I. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors discuss how the gas-filled orbitron maser operates reliably in the steady-state. The output consists of narrow lines that do not shift in frequency as the discharge current is varied. A typical spectrum of the microwave emission is shown. The primary reason that the device was previously operated in the pulsed mode was because the device was intended as a very-high-frequency source. Since the frequency scales as the square root of the applied voltage, and a gas-filled device cannot hold off voltages much over 1000 V, pulsed operation was used to obtain high transient voltages. However, steady-state operation is much more convenient for studying the physics of the device. The line spectrum emitted suggests that the alternate explanations of orbitron operation as two interpenetrating electron beams involved in a beam-plasma interaction is not applicable here.

23160 Transverse emittance equation with acceleration and compression. Hahn, K. (Lawrence Berkeley Lab., CA (USA)); Smith, L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC03-76SF00098. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Since both acceleration and bunch compression are required for a presently conceived inertial fusion driver (IFD), the understanding of their effects on the beam quality (emittance) is important. For an axially elongated beam, the 2-D transverse emittance at a given axial location is reasonable to consider, particularly with the velocity tilt; transverse emittance averaged over the entire bunch is not a useful quantity. The effect of space charge on the emittance of a drifting beam has already been studied. With the inclusion of acceleration and compression, the usual formula for emittance charge of a drifting beam is generalized. Applications to various acceleration schedules in a FODO transport channel are given. In particular, for the case of decompression in the head and tail of a bunch, the decrease of emittance is predicted.

23161 An injector for heavy ion fusion accelerator research. Rutkowski, H.L. (Lawrence Berkeley Lab., CA (USA)); Faltens, A.; Vanecek, D.; Pike, C.; Brodzik, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC03-76SF00098. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A multi beam injector is being built to provide 16-500 mA beams of C+ at 2 MeV energy. This injector will be used for physics experiments and for injection into an induction linac systems experiment. The sources are carbon cathode multiple arcs which provide plasma to a double grid plasma switch. The plasma switch is an planar electrostatic device which prevents ions from entering the extraction gap before the extraction voltage pulse is fired. The authors present data on the performance of this source in a test stand. The 1 μ sec current pulse will be injected into the acceleration column approximately 30 μ sec after the voltage pulse is applied to the column. This is to allow voltages to equilibrate and for the flat spot in the voltage pulse to be reached. The ions are accelerated in a column which consists of titanium electrodes mounted inside aluminum oxide insulator modules. Most of the sixteen beam holes are in thick plates which are machined to provide a set of alternating aperature lenses. These lenses focus the beam and inhibit propagation of backstreaming electrons. The first shelf of the column is being assembled for tests at the 1 MV level to be followed by tests with a single beam. The high voltage generator will be a 36 stage inductively graded Marx generator which resides in a pressurized vessel filled with a mixture of SF_6 and N_2.

23162 Plasma opening switch experiments on the Particle Beam Accelerator II. Sweeney, M.A. (Sandia National Labs., Albuquerque, NM (USA)); McDaniel, D.H.; Mendel, C.W.; Rochau, G.E.; Moore, W.B.S.; Mowrer, G.R.; Simpson, W.W.; Zagar, D.M.; Grasser, T.; McDougal, C.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Plasma opening switch (POS) experiments have been done since 1986 on the PBFA-II ion beam accelerator to develop a rugged POS that will open rapidly (< 5 ns) and efficiently (>80%) into a high impedance (> 10 ohm) load. In a recent series of experiments on PBFA II, the authors have developed and tested three different switch designs that use magnetic fields to control and confine the injected plasma. All three configurations couple current efficiently to a 5-ohm electron beam diode. In this experimental series, the PBFA-II Delta Series, more extensive diagnostics were used than in previous switch experiments on PBFA II or on the Blackjack 5 accelerator at Maxwell Laboratories. Data from the experiments with these three switch designs is presented.

23163 Implicit particle simulation of vortex coalescence in an electrostatic plasma. Schutkeker, J.; Tajima, T.; Kamimura, T.; Horton, W.; Morrison, P. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Using an implicit particle-in-cell simulation code with a particle weighting scheme that initializes a driving flow field the numerical simulation of the coalescence of vortices in an electrostatic plasma has been performed and a comparison of a theoretical model with point vortices has been made. Special attention is given to the limiting case of a purely sheared flow field which gives rise to the Kelvin-Helmholtz instability, and a simpler numerical theory involving eigenvalues of the Rayleigh equation is developed for comparison. The two comparisons show good agreement in the latter case to within 50%. The experimental observations are made that linearly stable modes can be nonlinearly destabilized by the growth of linearly unstable modes and that after coalescences vortices can pass through each other and separate again, leading to an oscillatory process of coalescence.

23164 A plasma lens for linear collider final focus. Nantista, C. (California Univ., Los Angeles, CA (USA)); Cline, D.; Norem, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Recent experimental and theoretical effort has been directed at designing a plasma lens for the SLC final focus. Plasma lenses of

the type under consideration work on the principle that the self forces of a beam pulse can be used to pinch the beam if electrostatic neutralization by the plasma is partially or wholly realized. It is predicted that the luminosity could be increased severalfold by such a lens. The plasma would be provided by a laser-ionized gas pulse. The operating modes of the lens are constrained by conflicting requirements of minimizing backgrounds and sensitivity to beam fluctuations. Results are presented of preliminary focusing experiments using a 20 MeV linac and tests of a high-speed, pulsed valve for gas injection. Proposed experiments are also described.

23165 CASK: An electromagnetic and electrostatic particle-in-cell simulation code with conformal boundaries. . Lottati, I. (Science Applications International Corp., McLean, VA (US)); Wai, P.K.A.; Drobot, A.T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The underlying basis of CASK is the mapping of a physical region onto a logical quadrilateral grid that represents the computational domain. The non-orthogonal mesh used in CASK is found by an elliptical solver used to generate the mapping of the logical grid to conformally fit the physical boundaries of the simulation domain. A set of high level subroutines has been written to numerically compute the gradient of mesh wide scalars, as well as the divergence and curl operators for mesh wide vector fields. The operators are correct to second order in the local mesh spacing. The algorithm selected for computing these operators contains a set of differencing coefficients to enable accurate numerical results on highly non-orthogonal curvilinear grids. The code contains both electrostatic and electromagnetic field solvers and particle orbit integration subroutines for plasma simulation. An efficient method has been developed to determine the cell location of particles on the mesh. The code has been used to find eigenmodes of cavities in the frequency domain; for transient electromagnetic problems; for intense electron beam injector design; and for simulation of a charge collecting biased probe immersed in a plasma. Representative results from these simulations are presented as well as details of the code structure and numerical algorithms employed.

23166 Absorbing boundaries for space plasma simulations. Buneman, O. (STAR LAB., Stanford Univ. (US)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

For the simulation of plasma phenomena in infinite space one must surround the computational domain by boundaries which absorb radiation. For spherical computational domains a rigorous absorbing condition can be formulated and implemented. This requires working in spherical polars and expanding surface data in spherical harmonics. A history of the past L steps must be kept for each L-th order harmonic in order to predict its value at the next step. For Cartesian meshes and box-shaped boundaries, Lindman's method can be applied on each of the six surfaces. It becomes very accurate if taken to high enough order. However it is arithmetic-intensive and it still leaves problems in the eight corners. Opting for the lowest order Lindman scheme and restricting angles of incidence to less than 45 degrees from vertical already achieves albedos (reflected/incident power) lower than 0.00003. Since finite differences methods for Maxwell's equations in vacuo are highly efficient, one can afford a wide buffer region between radiating plasma sources and boundaries, thereby reducing angles of incidence. In this paper, a simple PC program using the low-order method is used to demonstrate how an expanding wave is apparently fully absorbed at the boundaries.

23167 Computer simulations of finite plasmas convected across magnetized plasmas. Galvez, M. (CHNE Univ. of New Mexico, Albuquerque, NM (US)); Barnes, C.; Gisler, G. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report a two-dimensional electrostatic particle-in-cell code used to simulate the convection of a finite-slab of neutral plasma across a uniform magnetic field. The simulations show that the plasma is convected with a velocity that approaches the injection velocity for denser plasmas. The plasma losses p_y momentum with distance due to erosion effects. They have identified three mechanisms that cause erosion of the plasma: the erosion of the charge layers due to the velocity shear, the erosion of the charge layers due to their expansion along the magnetic field lines, and the erosion of the head of the stream due to Larmor-radius effects. The simulations also show that these erosions have greater effect for denser plasmas.

23168 Progress in ion beam research at Sandia National Laboratories. Stinnett, R.W.; Lockner, T.R.; Johnson, D.J.; Coats, R.S.; Mehlhorn, T.A.; Woodworth, J.R.; Leeper, R.J.; Desjarlais, M.P.; Bieg, K.W.; Pregenzer, A.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report their progress in ion beam production and focusing in both radial focusing and extraction geometries. The voltage and current operating point of applied B ion diodes in both geometries can now be understood through consideration of the virtual cathode location, as determined from pressure balance. Enhanced ion current, depends sensitively on the magnetic field profile in the diode region. Experiments on Sandia's Particle Beam Fusion Accelerator (PBFA) II have demonstrated efficient ion beam generation, with 0.6 MJ of ions produced with 80% ion efficiency on experiments at the 3/4 energy level. With the flashover ion sources presently used on PBFA II, approximately half of the ion are protons. Horizontal FWHM proton focuses of approximately 5 mm have been obtained at diode voltages of over 5 MV. Experiments have revealed a linear scaling of FWHM with anode-cathode gap. Experiments and simulations have provided information on the effects of both solenoidal and self-field focusing in the diode.

23169 Theoretical analysis of wire-guided ion beam transport. Watrous, J. (JAYCOR, Vienna, VA (US)); Ottinger, P.F.; Mosher, D.; Neri, J.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Ion beam transport using a current carrying wire to provide an azimuthal confining magnetic field has been proposed for inertial confinement fusion applications. The authors discuss several aspects of this transport scheme investigated theoretically to determine whether or not the scheme is viable. An important issue is how much of the injected ion beam current can be successfully transported. Propagating beam ions execute betatron-like oscillations around the wire, and must have sufficient angular momentum to avoid collision with the wire. The fraction of the injected ion beam with sufficient angular momentum and with small enough radial excursion to match pellet dimensions is determined by the extraction ion diode focusing geometry, the wire size, and the current carried by the wire. A second issue is the length of the standoff, or ballistic drift region, between the end of the guide wire and the target. The 1/r dependence of the guide magnetic field causes ion trajectories to bend inward sharply close to the wire, indicating that the standoff could be severely limited. Because of packing constraints, the standoff determines the maximum number of beams that can be delivered to the target, which in turn determines the amount of current each beam must carry. Packing constraints also determine the positioning of the return current wires, which produce magnetic fields that can strongly influence the trajectories of beam ions. The advantages and disadvantages of the wire guided scheme are discussed and compared to the standard z-discharge transport scheme.

23170 Final focusing of Z-discharge transported ion beams. Neri, J.M. (Naval Research Lab., Washington, DC (USA). Plasma Physics Div.); Boller, J.R.; Cooperstein, G.; Mosher, D.; Ottinger,

P.F.; Scherrer, V.C.; Stephanakis, S.J.; Watrous, J.J.; Goodrich, P.J.; Hinshelwood, D.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

An experimental program is underway to demonstrate final focusing of transported ion beams. Z-discharge channels can be used to efficiently transport ion beams from the ion source to an ICF target, providing isolation and distance for time-of-flight power compression. Channel stability and beam energy loss constraints force a minimal channel diameter for a given ion beam power. Final focusing uses an additional short z-discharge with larger current to reduce the spot size of the ion beam from the channel diameter to the target diameter. Results and analysis of the program are presented.

23171 Plasma armatures in large bore launchers. Barber, J.P. (IAP Research, Inc., Dayton, OH (USA)); Marshall, R.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Almost all experimental observations of plasma armatures in railguns have been madein bores less than 20 mm in diameter. A serious velocity limiting interaction with the bore walls has been identified. The plasma radiates to the bore walls at power levels of several GW/m^2. The bore walls ablate and the ablated material enters the armature resulting in an apparent drag. In this paper, the authors examine the ablation induced drag as bore size is increased. Using a 3-D computational model they determine plasma temperature and pressure distributions. Bore wall ablation and drag are then computed. They find that plasma armature length and resistance increase only slowly with bore size. Radiant power densities do not change significantly and the deleterious affects of ablation induced drag decrease.

23172 Excitation of high frequency, electrostatic waves in the magnetospheres of the outer planets. Roth, I. (California Univ., Berkeley, CA (USA). Space Sciences Lab.). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Observations of high frequency waves on board Voyager 1 and Voyager 2 satellites show that with their approach to Jupiter, Saturn and Uranus, electrostatic waves are excited within distances of ten planetary radii. Among the most prominent waves are the n + 1/2 cyclotron electron Bernstein modes. The most intense waves are excited intermittently at the local upper hybrid frequency. Although the actual values of the plasma and gyrofrequency vary in all three planets, their relative ratios are comparable. In this paper, a model of two electron populations, including cold thermal and hot electrons with a loss cone, is considered. It is shown that crossing of two kinetic eigenmodes is able to destablilize the system when the density of the hot distribution and its positive gradient in velocity space are sufficiently large. The effect of perturbations on the distribution function extends the unstable spectrum to higher frequencies above the upper hybrid while the waves below the upper hybrid are enhanced by thermal fluctuations. The nonlinear development is analyzed with the help of particle simulations.

23173 Design studies of an electrostatic quadrupole channel for transport of a high-brightness H^- beam and comparison with gas focusing. Chang, C.R. (Univ. of Maryland, MD (US)); Horowitz, E.; Reiser, M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Transport of low-energy, high-brightness H^- beams from the ion source to the radio-frequency quadrupole (RFQ) accelerator requires the solution of several physics and engineering problems to avoid particle losses and emittance growth. The authors developed a conceptual design of an electrostatic quadrupole channel for transport of a 120 keV, 120 mA, H^- beam into a 425 MHz RFQ with low emittance growth and high transmission efficiency. This design satisfies several constraints imposed by voltage breakdown and beam optics considerations. The system will consist entirely of electrostatic lenses which prevent plasma build-up and eliminate possible emittance growth from plasma fluctuations. Pertinent design features a worst case non-linear analysis for the electrostatic quadrupole channel, and first results of a particle simulation code used to study beam loss and emittance growth are reported. As an alternative to the electrostatic quadrupole concept, gas focusing is being investigated for transporting low-energy H^- beams. Recent results from the numerical simulations of such a gas focussing channel are presented.

23174 Numerical simulation of plasmas on an unstructured grid. Drobot, A.T. (Science Applications International Corp., McLean, VA (US)); Friedman, A.; Fritts, M.J.; Lottati, I.; Nielsen, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The use of unstructured grids provides some inherent advantages in the accurate simulation of plasma problems which involve complex configurations and where the treatment of complicated boundaries is important. The use of a triangular grid in two dimensions, and of a tetrahedral grid with arbitrary connectivity in three dimensions, allows a straightforward representation of complex geometries and naturally allows the resolution of the mesh to vary according to the requirements of a problem. We have constructed a very simple and efficient data structure to represent unstructured grids for geometries with arbitrarily shaped boundaries. The data contains information about the location of vertices, edges, sides, and cells and permits with one degree of indirectness the implementation of algorithms for field solvers and for particle orbit integration. The numerical algorithms that have been constructed include a potential solver, an electromagnetic solver for both the time and frequency domain, and a particle-in-cell simulation. The efficiency and vectorization of the basic code functions are retained and yield timing results comparable with structured mesh codes. They describe the method of grid generation, the numerical algorithm's for a variety of applications, and present typical results. These include particle-in-cell plasma simulations as well as purely electromagnetic cases which illustrate powerful features of local grid refinement for cavity and scattering problems.

23175 Large high-field spaceborne experimental magnet systems: Design considerations. . Gaudreau, M.P.J. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Sullivan, J.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Currently, several programs are being planned which will place large high intensity magnets in low Earth orbit, i.e., inductive storage for electromagnetic launchers, magnetic spectrometers for cosmic ray studies, and artificial magnetospheres for plasma physics experiments. However, large high field magnets have yet to be operated in space, and possible environmental plasma effects of the magnets are open issues. In this paper the authors discuss design constraints for normal, superconducting, and permanent magnets from the perspective of possible precursors experiments appropriate for various space missions. For the magnetic field, the order (dipole, quadrupole), orientation with respect to Earth field and spacecraft, field intensity, and pulse shape discussed with respect to their impact on the spacecraft design, mission profile, and ground operations. Parametric optimization of the magnet system-cost, weight, size, power, intensity, and pulse shape flexibility are discussed, and estimated achievable performance for the various magnet systems and mission options are given.

23176 Dielectric-in-cell and N-body-dielectric simulations of $E\vec{}$ x $B\vec{}$ drifting plasma clouds. Hansen, P.J. (Iowa Univ., Iowa City, IA (USA). Dept. of Physics and Astronomy); Borovsky,

J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Two computational methods for simulating E→ x B→ drifting plasma clouds are demonstrated. Both methods involve representing the plasma cloud by a large number of dielectric elements, each of which E→ x B→ drifts in a local electric field. This local electric field is the sum of an externally imposed uniform electric field and a polarization electric field. The local value of the polarization electric field depends on the configuration of the entire plasma cloud, hence it depends on the location of all of the dielectric elements that make up the cloud.

23177 **Predictions from the van der Pol equation applied to high power microwave phase-locking experiments at Physics International.** Price, D. (Physics International Co., San Leandro, CA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In this paper, the van der Pol equation is evaluated as a model for an experiment in which a high power cavity vircator ws driven by a relativistic magnetron. It is shown that Adler's inequality gives a necessary but not sufficient condition to achieve phase locking between the driving magnetron and the driven vircator oscillations. The amplitude of the entrained oscillations is found as a function of the injected magnetron power, the initial frequency detuning and other system parameters. The stability of these oscillations is examined. Not all entrained states are stable. Boundaries between stable and unstable states are given. It is also shown that the driven oscillator can operate as a beat wave source. Predictions are compared to measurements to validate the model. A similar analysis is extended to two coupled van der Pol equations which model the PI, phase-locked relativistic magnetron experiments.

23178 **Efficiency optimization in a CARM amplifier.** Kho, T.H. (California Univ., Los Angeles, CA (USA). Dept. of Physics); Lin, A.T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Computer simulations are used to examine the detailed physics of magnetic field tapering and frequency detuning in a CARM amplifier, and the dependence of its efficiency on electron beam current and input wave intensity. It is found that, depending on the initial frequency mismatch, tapering the magnetic field with either a negative or positive gradient can enhance the efficiency over that of the resonantly tuned CARM. The effects of different tapering strategies is presented. The ability of tapering to enhance the efficiency depends on the initial frequency mismatch; a physical explanation is presented for this observation. For a given set of parameters, the efficiency increases with beam current up to a critical current, beyond which the efficiency decreases with increasing current. The decrease in efficiency results from the dominance of force bunching over inertial bunching in the electron-wave interaction. In the force bunching regime, neither magnetic field tapering nor frequency detuning is effective in enhancing the efficiency.

23179 **Analysis and nonlinear simulation of quadrupole and dipole wiggler FELs for millimeter waves.** Chang, S.F. (Wisconsin Univ., Madison, WI (USA)); Scharer, J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

An FEL amplifier with a helical quadrupole wiggler is investigated analytically and numerically. A 3-D simulation code is utilized to examine the nonlinear evolution of circular waveguide modes as well as the characteristics of relativistic particle motion, which illustrate a strong focusing effect. The simulation predicts a 0.55 dB/cm, 2% efficiency, and 8% bandwidth for the optimum TE_{21} mode at 300 GHz for a untapered wiggler. Mode competition for an over-moded waveguide and a nonlinear wiggler taper for efficiency enhancement are examined for a linear dipole wiggler in a rectangular guide. It is found that the maximum TE_{01} mode efficiency is 53% at 280 GHz and that the TM_{21} mode power can be as high as 28% in the constant wiggler level region. The dipole wiggler case is compared with that from the LLNL wiggler-averaged code WFEL.

23180 **High efficiency 1.7 GHz gyropeniotron amplifier.** Ganguly, A.K. (Naval Research Lab., Washington, DC (USA)); Ahn, S.; Zaidman, E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Proposed applications require a highly efficient, high power source to drive accelerators in the .8 GHz - 1.7 GHz region. Klystrodes have produced power at 1 MW level at 0.45 Ghz with an efficiency in excess of 75%. It is, however, difficult to operate klystrodes in the frequency range of .8 GHz - 1.7GHz. The gyropeniotron is projected to operate at high frequencies with an efficiency in excess of 75%. The saturated power and efficiency of the gyropeniotron amplifier in a cylindrical waveguide with the slotted structure are calculated from a three-dimensional self-consistent theory. Design parameters are provided for a 1.7 GHz gyropeniotron operating in the 2nd cyclotron harmonic with a 100 kV, 10A beam. For an ideal axis-encircling beam, the calculated efficiency is 78%. For a realistic beam with 2% axial velocity spread and 5% guiding center spread, the efficiency is only reduced to 66%. The saturated power is 660 kW. Power in excess of 1 MW can be obtained with higher energy beam. Gyropeniotron amplifiers have potential for the required applications.

23181 **A review of the modeling of low pressure discharges for plasma chemistry and plasma processing.** Kushner, M.J. (Univ. of Illinois, Champaign, IL (US)); Kline, L.E. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 4B9.

The current state of the art in computer modeling of low pressure, non-equilibrium plasma processing is reviewed. Plasma deposition and etching of thin films for electronic applications are emphasized. The authors describe the current progress towards first principles models which use basic data describing electron-molecule interactions, gas phase reactions, and surface chemical reactions to predict the behavior of these plasma processes as a function of controllable process parameters. The present models are discussed in terms of three submodels: discharge electron kinetics models, chemical kinetics models, and surface kinetics models. For each submodel they discuss the numerical techniques, input data, predicted parameters, and comparison to experiment. The relationships between submodels are also discussed.

23182 **Low-Z gas puff implosions.** Hsing, W.W. (Sandia National Labs. (US)); Porter, J.L.; Spielman, R.B. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC04-76DP00789. (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 2P50.

The authors have imploded helium gas puffs on the 2Ω Supermite accelerator (1.3 MA, 80 nsec implosion time) and measured the stagnation characteristics both in the presence and absence of a target. The target consisted of 1000 A of Al coated over a 2-μm-thick, 3-mm-diameter annulus of parylene. They have measured the radiation using bolometers, XRDs, photoconductive detectors and a time-resolved x-ray pinhole camera. They have observed a well-defined region of stagnation in the absence of a target. In the presence of a target, they have measured the K-shell aluminum radiation created by the stagnation of the helium onto the target. They compare the stagnation characteristics of helium with the stagnation of neon and nitrogen.

23183 Two-dimensional simulations of imploding gas puff plasmas. Roderick, N.F. (New Mexico Univ., Albuquerque, NM (USA)); Hussey, T.W. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report two dimensional single fluid magnetohydrodynamic simulations conducted to investigate short wave length and long wavelength disturbances of gas puff plasma implosions including the effects of gas injection and power flow to the plasma annulus. The numerical calculations were carried out using the two-dimensional single-fluid MHD code MACH2 for different plasma density profiles and electrode geometries. Results show the effects of long wave length disturbances resulting from the gas injection and short wavelength instabilities resulting from instabilities of the plasma magnetic field interface.

23184 Nonlinear studies of axis-encircling electron beam with off-centering and field tapering effects. Ayres, V. (Naval Surface Warfare Center, Silver Spring, MD (USA)); Choe, J.; Boulais, K.; Uhm, H. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A self-consistent nonlinear analysis of an axis-encircling electron beam in a vane circuit oscillator has been developed. From this analysis, optimized quantities with respect to energy, current, vane depth, and magnetic field are determined and compared with experiment in this paper. The analysis also includes more realistic parameters, such as the off-centering effect and the tapering of the magnetic field. These are investigated within the following context. Efficient production of radiation by both cusptron (via the negative mass instability) and peniotron mechanisms depends critically on the electron beam quality. For the cusptron, the off-centering is always damaging. The cyclotron motion does not coincide with the system azimuthal direction, therefore energy conversion to the azimuthal RF wave is less efficient. Magnetic tapering is investigated both as a realistic experimental parameter and for the purposes of designing an adiabatic compression (to reduce the size of the beam to a more favorable interaction position). It has been shown that adiabatic compression actually reduces the off-centering effect. An ideal adiabatic compression is discussed.

23185 Small and large versions of the IGNITEX experiment. Montalvo, E. (Texas Univ., Austin, TX (USA)); Carrera, R.; Rosenbluth, M.N. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Small and large versions of the basic IGNITEX ignition experiment are proposed and analyzed. The philosophy that supports both concepts is explained. The basic IGNITEX machine is a high field (B=20T) compact, single-turn tokamak (R=1.5m).with high plasma current (I = 12 MA) This tokamak machine uses unconventional magnet and power supply systems that allow the generation of the high magnetic field required for ohmic ignition. The design is based on the assumption that Kaye-Goldston (L-mode) energy confinement time scaling represents adequately the possible confinement degradation induced by alpha particle heating. The machine is designed to provide high ignition margin and a wide operational range of densities and temperatures within the constraints of stability, disruption limits, and total length of the discharge. The physics aspects of the experiment have been extensively studied. The results indicate good experimental characteristics for plasma equilibrium and stability and for alpha particle containment. The experiment at the time of ignition is described. The basic IGNITEX experiment has high ignition margin for present scaling expressions but it is not designed to ignite under the more pessimistic Goldston scaling. The descriptions of the large and small IGNETIX devices are presented. Their characteristics and preliminary analysis are given. Design modularity is emphasized.

23186 In-vessel maintenance on the IGNITEX experiment. Ling, J. (Texas Univ., Austin, TX (USA)); Barrington, M.; Carrera, R.; Tesar, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The fusion experiment IGNITEX uses a single-turn-coil- tokamak to reach ignition conditions in a deuterium-tritium plasma. Because of the high energy neutrons produced during plasma ignition, the in-vessel zone of the device will become highly activated during the DT phrase of the experiment. The in-vessel remote maintenance system (IVRMS) is described. It should permit maintenance of the first-wall system as needed for the adequate operation of the ignition tokamak. The essential tasks to be performed by the IVRMS are: inspection of first wall and diagnostic penetrations, for damage and vacuum leaks; and repair of damaged areas by welding and beryllium-spray-coating techniques.

23187 Vacuum and fueling systems for the IGNITEX experiment. Hallock, G. (Texas Univ., Austin, TX (USA)); Booth, W.D.; Carrera, R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The results of preliminary studies of the vacuum and fueling requirements for the proposed fusion ignition experiment IGNITEX are presented. An initial design for the vacuum pumping and plasma fueling system is given. The IGNITEX vacuum system must meet the demands of providing sufficient pumping speed to reach a base pressure of about 10^{-8} Torr to provide a clean environment for plasma formation. In addition, the pumping speed should meet the requirements during the discharge cleaning cycle. The design of the vacuum pumping system including layout and location and structure of the vacuum ports required for pumping and diagnostic access is presented. Two different types of pumping systems - turbomolecular pumps and cryrogenic pumps have been considered. The advantages and disadvantages of each type of pumping system are analyzed.

23188 SRX- precursor to large scale high beta plasma devices. Mendelsohn, S. (Grumman Corp., Plainsboro, NJ (USA). Corporate Research Center); Todd, A.M.M.; Wexler, H.; Navratil, G.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors describe a second regime experiment and present calculations illustrating several possible operating scenarios, external and internal mode stability boundaries and other experimental features needed to evaluate and test high beta tokamak theories. Access to and operation in the second regime employing a large aspect ratio range (R/a = 6 to 9) device is discussed. Large aspect ratio was chosen to reduce required heating power for second regime studies and to permit large aspect ratio confinement experiments under ohmic, NBI, and ECH heating conditions. In addition, it leads to simplified machine geometry based on reduced stress from relatively low values of plasma current and magnetic field strength. Design features include an inside null divertor for possible confinement advantages of H-mode operation, to test divertor physics at high beta and to provide added flexibility to control the plasma boundary. A close-fitting, adjustable conducting shell providing stabilization against external modes will allow study of wall-plasma separation effects and permit R/a variation.

23189 Operation of the IGNITEX tokamak. Eways, S.; Carrera, R.; Dong, J.; Hallock, G.; Montalvo, E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The fusion ignition experiment IGNITEX will use a single-turn tokamak to produce and control ignited plasmas by heating a fuel

mixture with ohmic heating alone. The operations of the IGNITEX tokamak from breakdown to shut down is described. The pulse length of the discharge is extended by precooling the magnet structure to liquid nitrogen temperature between pulses. The use of RF cavity resonance to breakdown the neutral gas and initiate the plasma discharge in a controllable and reproducible way is analyzed. A relatively low power, moderate frequency RF field at a toroidal cavity resonance mode should build up a sufficient electric field strength to produce an RF discharge at high density. The potential advantages of breaking down the gas by resonant cavity modes in the IGNITEX tokamak are discussed.

23190 **Design of a laser-produced lithium anode plasma experiment on the Helia extraction diode.** Bieg, K.W. (Sandia National Labs., Albuquerque, NM (USA)); Tisone, G.C.; Bailey, J.E.; Hamil, R.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Recent experimental evidence on PBFA II has suggested that poor source turn-on and nonuniformity may contribute to the late focusability achieved with passive lithium ion sources to date, further emphasizing the need for a pre-formed anode plasma. The BOLVAPS/LIBORS ion source, now under development, is such an active source but poses some formidable technical challenges. As a result, the authors are proposing to field a direct laser-produced lithium anode plasma source on the Helia extraction diode experiment, with eventual application to PBFA II. Previous experiments have shown that a high-density lithium plasma can be produced by direct laser irradiation of a solid lithium surface with a pulsed dye laser (LIBORS) tuned to the Li I 2s-2p resonance line (670.8 nm). These measurements have also suggested that the plasma formation process, and therefore the laser energy requirement, is dominated by the thermal energy required for vaporization with the long-pulse (1 μsec) LIBORS laser. The authors discuss how they developed a simple model of this process and have investigated the effects of laser pulse length, lithium film thickness, substrate material, and laser wavelength on the threshold for lithium plasma production.

23191 **Phase locking of ultra-high power relativistic magnetrons.** Sze, H. (Physics International Co., San Leandro, CA (US)); Benford, J.; Smith, R.R.; Woo, W. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 5B8.

Phase locking of ultra-high power ($\geq$ GW) microwave oscillations has been achieved. In this article, the authors present experimental and theoretical results of an on-going program to investigate the feasibility of phase-locking of two simultaneously driven relativistic magnetrons. Theoretically, they discuss phenomenological modeling using relativistic pulse shapes. Experimentally, they describe experimental setup and operating characteristics, examine locking criteria, present temporal phase measurements, and compare with analytical results of the phenomenological modeling.

23192 **Pulsed power driven x-ray laser research at Physics International Company.** Nash, T. (Physics International Co., San Leandro, CA (US)); LePell, P.D.; Krishnan, M. vp. of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 5A7.

The DNA/PITHON generator was used to produce hot, dense plasmas in z-pinch configurations. Up to 50 MM long, 1 mm diameter plasmas of Kr, Al, Na and other species were produced, with densities N_e - 10^{20} cm^{-3} and temperatures T – 300-800eV. Time and space resolved spectral measurements were made of these plasmas using x-ray crystal and XUV (MCPIGS) spectrographs and x-ray pinhole framing cameras. Several x-ray laser schemes were explored: collisionally pumped, Ne-like lasers; three-body recombination lasers in H-like and Li-like ions; and resonant photo-excitation of NeIV by NaX line radiation. The results of these ongoing experiments and their implications for future research are presented and discussed.

23193 **The pulsed power systems for the LSX field reversed configuration experiment.** McDonald, K.F. (Spectra Technology, Inc., Bellevue, WA (USA)); Mayerchak, M.A.; Dettart, T.E.; Hedeen, P.F.; Hoffman, A.L. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

This paper reports on a reversed-field theta pinch experiment, called LSX (large s experiment), to generate field reversed configurations (FRC) of reactor relevant sizes. The principal parameters of the device are a set of single turn theta coils of 0.9 m diameter, with a total length of 4.5 m. The peak forward field is 7.5 kG, applied with a 25 μsec risetime. The FRCs will be formed using slow, programmed formation techniques which rely upn ohmic heating and axial compression heating rather than the more standard theta pinch method of radial shock heating. LSX's basic engineering features are reverse bias and forward field capacitor banks, programmed formation end coils and power supplies, multipole flux retention and stabilization fields, preionization sources, and the necessary ancillary systems. The authors provide an overview of the LSX physics, discuss the operating modes and design philosophy, describe the capacitor banks, energy storge modules and ancillary systems, and discuss the fault prevention techniques and fault sequences.

23194 **Performance of the Laguna pulsed power system.** Goforth, J.H. (Los Alamos National Lab., NM (USA)); Caird, R.S.; Fowler, C.M.; Greene, A.E.; Kruse, H.W.; Lindemuth, I.R.; Oona, H.; Reinovsky, R.E. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The goal of the LAGUNA experimental series is to accelerate an annular aluminum plasma z-pinch to greater than one hundred kilojoules of implosion kinetic energy. To accomplish this, an electrical pulse >5.5 MA must be delivered to a 20 nH load in –1 μs. The pulsed power system for these experiments consists of a capacitor bank for initial energy storage, a helical explosive-driven magnetic-flux compression generator for the prime power supply and opening and closing switches for power conditioning. While the authors have not yet achieved their design goal of 15 MA delivered to the inductive store of the system, all major components have functioned successfully at the 10 MA level. Successes and difficulties experienced in these experiments are described.

23195 **A low inductance vacuum convolute for Z-pinch research.** Spielman, R.B. (Sandia National Labs., Albuquerque, NM (USA)); Hsing, W.W.; McDaniel, D.H.; Spence, P.W.; Nielsen, K.E. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. American Society for Surface Mining and Reclamation, Princeton, WV (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors discuss how they tested a low inductance, vacuum convolute for driving Z-pinch loads on Proto-II. The Proto-II vacuum section has four separate insulator stacks (1 m dia., 16 cm high) feeding four disk feeds. These disk feeds are coupled together by twelve, vertical magnetically-insulated transmission lines (MITLs) that are, in turn, convoluted into a single-disk MITL near the load. This convolute adds all of the inductance of the individual feeds in parallel, resulting in a total system inductance of 6.5 nH and short circuit currents as great as 9 MA. The vertical-to-disk convolute includes regions of poor magnetic insulation, which result in significant electron losses for the Z-pinch loads.

99 GENERAL AND MISCELLANEOUS

23196 (LBL–28101) **Nuclear science and engineering at Berkeley: The early days.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). Nov 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891277–1: Symposium honoring Thomas H. Pigford, Berkeley, CA (USA), 1 Dec 1989). Order Number DE90007076. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The life and times of Thomas Pigford as seen through the eyes of Glenn Seaborg. Given at a symposium honoring Thomas. (JEF)

9901 Management

Refer also to citation(s) 21308, 21310, 21434, 22312

23197 (AERE-OR/EMS–16) **Health Physics, Safety and Medical Services report for 1988.** Burt, A.K.; Bird, R.W. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. Aug 1989. 73p. Order Number DE90620439. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This annual report summarizes Health Physics and Medical Services activities at Harwell Laboratory. Topics covered include liaison with emergency authorities, organization, policy, training and staffing problems, major changes to plant and the decommissioning projects. Monitoring of the working environment and that surrounding the Laboratory are discussed, together with surface contamination and waste disposal. Summaries of doses for 1988, and cumulative doses in selected buildings for Harwell staff and contractors are presented in tabular form and a summary of attendance for medical treatment is also given. (UK).

23198 (CONF-900566–1) **Research and development quality assurance planning.** Hoke, P.B. Oak Ridge National Lab., TN (USA). 14 May 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1990 American Society for Quality Control (ASQC) congress; San Francisco, CA (USA); 14 May 1990. Order Number DE90003687. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Planning for quality assurance (QA) in research and development (R & D) is like stealing eggs without waking up the chickens. The QA program should be as unobtrusive as possible. Researchers require a QA program that affords them an environment capable of supporting repeatable experiments with accurate data without unduly stifling their creative abilities. Careful advance planning ensures that the intensity of control provided by quality-related systems is commensurate with the importance and scope of the activities being performed. Good scientific practices applied to small bench-scale projects may require minimal additional controls. As projects increase in size and complexity the controls imposed through planning must, by necessity, be increased. Research and development QA planning, just like any other planning, involves all affected individuals. The application of control systems is determined by factors such as customer or sponsor requirements, the importance of an item or activity to the experiment's success, and the organizational complexity of the project. Many larger experiments are highly dependent on quality-related support activities such as calibration, engineering design, and inspection provided by organizations outside the R & D group. Since, in most cases, the expense of support activities is taken directly from funds available for research, it is important for the researchers to be involved in the planning efforts to help determine and agree with the level of QA effort required. A single plan will often suffice for organizations engaged in large numbers of similar experiments. Complex experiments may require unique QA plans or additions to existing plans. Once implemented, the R & D QA plans, like any others, require audits or surveillances and may require revisions if the scope of the experiment changes. 1 ref., 1 fig.

23199 (SAND–89-2698) **PC-based information systems used in planning and coordinating the Building 823 exclusion from Tech Area 1.** Tolendino, C.D. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 49p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90008133. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the application of word processing, graphics and data base software to the task necessary for the exclusion of Building 823 from the secure technical area at Sandia National Laboratories. In particular, this report focuses on the development of the building floor plans layouts and the space/personnel data base which were used by management to plan and coordinate the project. Once the project is complete, these information systems will continue to be maintained by other personnel for administrative purposes. The software developed has potential applicability to other facilities where administrative monitoring or space assessment is required. 6 figs.

23200 (SAND–89-2700C) **Analysis of software for security-critical systems.** Axline, R.M. Jr.; Smith, R.E.; Grady, M.F.; Barger, T.I. Sandia National Labs., Albuquerque, NM (USA). [1989]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005106–1: 13. annual conference of the Computer Security Group, Augusta, GA (USA), 8-10 May 1990). Order Number DE90007286. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories (SNL) performs software security analyses of many systems having strong security requirements. This paper gives an overview of a software security analysis methodology that has evolved at SNL. This methodology is based on experience gained in the analysis of critical software-controlled systems. The paper describes analysis activities and how they relate to the traditional software life cycle. Topics discussed include: planning for the analysis; supporting the development and documentation of security requirements; identifying and analyzing the threat; acquiring and utilizing software design and implementation materials; identifying positive design features; scaling the analysis effort to the threat; analyzing the high-level design; analyzing the source-code and target implementations; reporting results; interacting with system and component development groups; and supporting the authentication of the software product before it is fielded. The paper also stresses the importance of independence of analysis and development groups.

23201 (UCRL–101159) **How to select members for an audit team.** Dronkers, J.J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900566–2: 1990 American Society for Quality Control (ASQC) congress, San Francisco, CA (USA), 14 May 1990). Order Number DE90008320. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we will consider the putting together of an audit team. Actually a more formal way to state this is that in this paper we will consider the selection of the members of an audit team. The formal way makes certain implicit assumptions. First, that there is an audit team, or, to put it differently, audits are done by more than one person. Second, that there is a selection process. That is, there is a method by which a few persons are chosen in preference over other persons to come and do an audit. 12 refs.

9902 Mathematics and Computers

Refer also to citation(s) 21206, 21207, 21444, 21448, 21457, 21458, 21501, 21511, 21525, 21527, 21532, 21547, 21548, 21611, 21615, 21652, 21658, 21669, 21689, 21700, 21723, 21726, 21733, 21734, 21741, 21742, 21781, 21794, 21797, 21798, 21799, 21803, 21837, 21841, 21845, 21846, 21847, 21849, 21850, 21887, 21996, 22000, 22001, 22004, 22005, 22008, 22036, 22037, 22050, 22071, 22079, 22109, 22247, 22248, 22249, 22250, 22252, 22260, 22261, 22262, 22263, 22264, 22266, 22267, 22276, 22321, 22324, 22330, 22333, 22337, 22342, 22371, 22398, 22399, 22408, 22420, 22465, 22466, 22467, 22468, 22472, 22484, 22590, 22591, 22749, 22793, 22874, 22876, 22920, 22973, 22976, 22978, 23056, 23074, 23136, 23165, 23166, 23167, 23174, 23176, 23200, 23250, 23255, 23256

23202 (AD-A–214481/4/XAB) **Vision-based navigation and parallel computing. Annual report No. 1, May 1988-May 1989.** Davis, L.S.; DeMenthon, D.; Bestul, T.; Harwood, D. Maryland Univ., College Park, MD (USA). Center for Automation Research. Aug 1989. 54p. Available from NTIS, PC A04/MF A01.

This report describes research performed during the period May 1988-May 1989 under DARPA support. The report contains discussion of four main topics: (1) On-going research on visual navigation, focusing on a system named RAMBO, for the study of robots acting on moving bodies; (2) Development and implementation of parallel algorithms for image processing and computer vision on the Connection Machine and the Butterfly; (3) Development of parallel heuristic search algorithms on the Butterfly that have linear speedup properties over a wide range of problem sizes and machine sizes; and (4) Development of Connection Machine algorithms for matrix operations that are key computational steps in many image processing and computer-vision algorithms. This research has resulted in twelve technical reports, and several publications in conferences and workshops.

23203 (AD-A–214502/7/XAB) **Hybrid (optical/electronic) computing and digital optical computing. Final report, 1 September 1985-31 August 1988.** Lee, S.H. California Univ., San Diego, CA (USA). 31 Aug 1988. 29p. Available from NTIS, PC A03/MF A01.

Hybrid optical-analog/electronic computing is performed for optical image processing, optical pattern recognition, and optical solution of partial differential equations. For example, image processing designed and fabricated space-variant filters to optically implement numerous space-variant transformation (e.g., Hough transform for detection of high-order parametric curves, coordinate transforms to detect rotation and scale-invariant features of images, etc.). For spike removal from noisy images, one can develop a new parallel algorithm suitable for optical/analog/electronic hybrid implementation. This parallel algorithm is space-variant and performs better than the space-invariant low-pass filter and the time-consuming median filter. Digital optical computing research develops nonlinear optical devices and studies their uses in parallel architectures for implementation of parallel algorithms. The nonlinear optical devices are based on integrating silicon with PLZT. LPCVD techniques to deposit polycrystalline Si onto the electro-optic PLZT substrate and then recrystallizing the polysilicon using an Ar+ laser are used to produce single crystal silicon grains, to fabricate and test a 12 x 12 electrically addressed spatial light modulator (SLM) array and a 16 x 16 optically addressed SLM array. Optical parallel computing architectures are investigated by different interconnection topologies and holographic optical elements are generated to implement fully interconnected and hypercube interconnected topologies.

23204 (AD-A–214627/2/XAB) **Parallel functional computation. Final report, 15 June 1986-14 August 1989.** Oldehoeft, R.R. Colorado State Univ., Fort Collins, CO (USA). 9 Nov 1989. 13p. Available from NTIS, PC A03/MF A01.

The magnitude of problems that people need to solve using automatic computation often exceeds the processing power of available sequential computers. However, most algorithms contain components that can execute concurrently instead of serially, and vendors have provided a variety of machines capable of parallel processing. But expected reductions in execution times did not always occur owing to ineffective utilization of available parallel hardware or excessive interprocessor communication. Programmers could sometimes manually optimize program structures to solve these problems, but this work is extraordinarily difficult, and not practical for large programs. Research into automatic parallelization follows two paths. First, because of the large investment in extant software, attempts continue toward compilers for conventional languages that map ordinary programs onto parallel architectures efficiently. Systems of this kind work best when programmers use certain easily recognizable forms in source programs and understand underlying parallel hardware. Second, research continues in this and other projects to design, implement, and evaluate new languages for which automatic parallel execution is more easily attainable.

23205 (AD-A–214635/5/XAB) **Parallel logic programming and parallel systems software and hardware. Progress report (Final), 1 April 1988-31 March 1989.** Minker, J. Maryland Univ., College Park, MD (USA). Dept. of Computer Science. 29 Jul 1989. 17p. Available from NTIS, PC A03/MF A01.

This progress report summarizes work performed under AFOSR-88-0152 on parallel logic programming, problem solving, and deductive data bases. A parallel problem-solving system, PRISM (Parallel Inference System), that was implemented on McMOB was ported to the BBN Butterfly machine. Two versions of PRISM were developed and are operational on the Butterfly: a message-passing ring-structure system and a shared-memory system. Experimental testing of PRISM on McMOB continued, while experiments were also conducted on the Butterfly systems. Three enhancements were made and completed during the grant period. These are: a capability to handle negated queries and a capability to assert and retract statements. In addition to the above, work continued in the area of informative answers to queries in deductive data bases. A thesis was completed on the subject. An interpreter was developed and is running, that can take restricted natural language as input and can respond with a cooperative natural language output. In the area of parallel software development, the following were accomplished. Theoretical work on slicing/splicing was completed. Tools were provided for software development using artificial-intelligence techniques. AI software for massively parallel architectures was started.

23206 (AD-A–214810/4/XAB) **Genetic adaptive system for image understanding and learning research. Phase 1. Final technical report, 1 February-1 August 1989.** Douthat, D.Z.; Ross, K.W. Institute for the Study of Intelligent Systems, Ann Arbor, MI (USA). Aug 1989. 28p. (ISIS–10037U/89-02C). Available from NTIS, PC A03/MF A01.

Original contains color plates: All DTIC and NTIS reproductions will be in black and white.

This report documents the efforts and results of initial phase research on machine learning directed at application for real-time machine vision and automatic target recognition. The particular paradigm pursued is based on genetic algorithms and classifiers modeled on the summation of Mendelian genetic recombination, Darwinian selection, and ecological notions of competition. This machine-learning approach is strongly supported by sound statistical theory. A second thread of research was the development of massively parallel computing hardware based on the Geometric/Arithmetic Parallel Processor (GAPP). This machine has a large number of processors, each one bit wide with a full Arithmetic/Logic Unit (full adder) and with local memory per processor. The basic research hypothesis of the subject effort has been that GAPP contained sufficient hardware capability to provide a substrate for a Classifier and Genetic Algorithm system. The goal has been demonstrated by constructing and running the necessary software on the GAPP, its controller and its host. The resulting fusion of software and hardware is called a Genetic Algorithm/Classifier Engine (GACE) in the same sense as a LISP engine or a data base engine. The resulting quantum jump in performance should open doors both to application and to more interesting and relevant research.

23207 (AD-A–214910/2/XAB) **Theory for graph-based language specification, analysis, and mapping with application to the development of parallel software. Doctoral thesis.** Bailor, P.D. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Sep 1989. 516p. (AFIT/DS/ENG–89-1). Available from NTIS, PC A22/MF A03.

Ageneralized formal language theory model and associated theorems were developed for the specification, analysis, and mapping of graphs and graph-based languages. The developed model, defined as a graph-generative system, is analyzed from a set theoretic, formal language, algebraic, and abstract automata perspective. As a result of the analysis, numerous theorems pertaining to the properties of the model, graphs, and graph-based languages are derived. The graph generative system model also serves as the basis for applying graph based languages to areas such as the specification and design of software and visual programming. The specific application area emphasized is the use of graph-based languages as user-friendly interfaces for wide-spectrum languages that include structures for representing parallelism. The goal of this approach is to provide an effective, efficient, and formal method for the specification, design, and rapid prototyping of parallel software. To demonstrate the theory's utility and the feasibility of the application, two models of parallel computation are chosen. The widely used Petri net model of parallel computation is formalized as a

graph-based language. The Petri net syntax is formally mapped into the corresponding syntax of a Communicating Sequential Processes(CSP) model of parallel computation where CSP is used as the formalism for extended wide-spectrum languages. Finally, the Petri net to CSP mapping is analyzed to demonstrate that the CSP specification formally behaves in a manner equivalent to the Petri net model.

23208 (ANL/TM–379-Rev.2) **Recommended documentation for computer users at ANL: Revision 2.** Caruthers, C.M.; Opitz, L.C. Argonne National Lab., IL (USA). Feb 1990. 96p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008137. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Recommended Documentation for Computer Users at ANL is for all users of the services available from the Argonne National Laboratory Computing and Telecommunications Division. This manual will guide you in selecting available documentation that will best fill your particular needs. Chapter 1 tells you how to use this document to select manuals and how to obtain them from the Computing and Telecommunications Document Distribution Counter. Chapter 2 contains tables that categorize available publications and identify available computer systems, applications, languages, and libraries. It serves as a rationale for the groupings of documents in Chapter 3. Chapter 3 lists publications by subject, with annotations indicating the skill level. Parts I and VIII cover publications of a general nature and publications on telecommunications and networks, respectively. Parts II, III, IV, V, VI, VII, and IX cover publications on specific computer systems. Chapter 4 contains abstracts of each publication, arranged alphabetically. Chapter 5 describes additional publications that contain bibliographies and master indices.

23209 (CONF-891273–2) **Performance characterization research at Oak Ridge National Laboratory.** Worley, P.H.; Heath, M.T. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989. Order Number DE90008745. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research in performance characterization at Oak Ridge National Laboratory is focused on providing tools for analyzing and modeling the behavior of parallel algorithms on parallel architectures. The ultimate goal is to attain a deeper understanding of the complex interaction between parallel algorithms and architectures in order to improve performance on existing architectures and to predict performance as an aid to designing new architectures. In this paper, we describe our approach and the current status of the research. 1 ref., 3 figs.

23210 (CONF-900290–2) **Hybrid Intelligent Perception System: Intelligent perception through combining Artificial Neural Networks and an Expert System.** Glover, C.W.; Spelt, P.F. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1. workshop on neural networks: academic/industrial/NASA/defense; Auburn, AL (USA); 5-6 Feb 1990. Order Number DE90007483. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents a report of work-in-progress on a project to combine Artificial Neural Networks (ANNs) and Expert Systems (ESs) into a hybrid, self-improving pattern recognition system. The purpose of this project is to explore methods of combining multiple classifiers into a Hybrid Intelligent Perception (HIP) System. The central research issue to be addressed for a multiclassifier hybrid system is whether such a system can perform better than the two classifiers taken by themselves. ANNs and ESs have different strengths and weaknesses, which are being exploited in this project in such a way that they are complementary to each other: Strengths in one system make up for weaknesses in the other, and vice versa. There is presently considerable interest in the AI community in ways to exploit the strengths of these methodologies to produce an intelligent system which is more robust and flexible than one using either technology alone. Perception, which involves both data-driven (bottom-up) and concept-driven (top-down) processing, is a process which seems especially well-suited to displaying the capabilities of such a hybrid system. This work has been funded for the past six months by an Oak Ridge National Laboratory seed grant, and most of the system components are operating in both the PC and the hypercube computer environments. Here we report on the efforts to develop the low-level ANNs and a graphic representation of their knowledge, and discuss ways of using an ES to integrate and supervise the entire system. 11 refs., 3 figs.

23211 (DOE/ER/25015–29) **Computation and graphics in mathematical research: Progress report, June 1, 1989–May 31, 1990.** Hoffman, D.A.; Spruck, J. Massachusetts Univ., Amherst, MA (USA). Jan 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER25015. Order Number DE90008429. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are actively developing and using interactive graphics software and numerical computation to study problems in global differential geometry and calculus of variations, the structure and motion of interfaces, and the simulation of plasma equilibrium and evolution. We have improved the hardware, software and design of our video animation facility and have begun to document our graphics software packages. 39 refs.

23212 (DOE/ER/25029–2) **Computer Science and Technology Board: Summary of activities, March 15, 1989–March 14, 1990.** Blumenthal, M.S. National Academy of Sciences - National Research Council, Washington, DC (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER25029. Order Number DE90008292. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Computer Science and Technology Board (CSTB) meets three times a year to consider scientific and policy issues in computer science as well as relevant problems in associated technologies. The objectives of the Board include: initiating studies involving computer science and technology as a critical national resource; responding to requests from the government, nonprofit foundations, and industry for advice on computer science and technology; promoting the health of the technology and other fields of pure and applied science and technology; and providing a base of expertise within the NRC in the area of computer science and technology.

23213 (JAERI-M–89-145) **A computer code TERFOC-N to calculate doses to the public due to atmospheric releases of radionuclides in normal operations of nuclear facilities.** Togawa, Orihiko (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 96p. (In Japanese). Order Number DE90759882. Available from NTIS (US Sales Only), PC A05/MF A01.

A computer code TERFOC-N has been developed to calculate doses to the public due to atmospheric releases of radionuclides in normal operations of nuclear facilities. This code calculates the highest individual dose and the collective dose from 4 exposure pathway; internal doses from ingestion and inhalation, external doses from cloudshine and groundshine. Foodchain models, which are originally referred to the U. S. Nuclear Regulatory Guide 1.109, have been improved to apply not only LWRs but also to other nuclear facilities. This report describes the employed models and the computer code, and gives a sample run performed by this code. (author).

23214 (JAERI-M–89-153) **Computation of synchrotron radiation from bending magnet and wiggler.** Sasaki, Shigemi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 44p. Order Number DE90759884. Available from NTIS (US Sales Only), PC A03/MF A01.

The programs for the VAX/MicroVAX computer were written in order to calculate various differential and total fluxes of synchrotron radiation from bending magnet and wiggler. These computer programs are here listed. (1) Vertical angular dependences of 'brightness' (angular flux density) and degree of circular polarization for a bending magnet case. [photons/s/mrad^2/0.1 %b.w./mA]. (2) Flux spectrum for a bending magnet or a wiggler case. [photons/s/mrad/0.1 %b.w./mA]. (3) Spectral brightness for a bending magnet or a wiggler case. [photons/s/mrad^2/0.1 %b.w./mA]. (4)

Spectral brilliance for a bending magnet or a wiggler case. [photons/s/mrad^2/mm^2/0.1 %b.w.]. (5) Angular dependences of flux and percentage of circular polarization for a bending magnet case. (Flux of elliptically polarized photon.) [photons/s/mrad/0.1 %b.w.]. (6) Flux through a slit. [photons/s/0.1 %b.w.]. (7) Flux spectrum through a slit. [photons/s/0.1 %b.w.]. (8) Integrated flux through a slit. [photons/s]. The calculated parameters will be useful for practical synchrotron radiation users. (author).

23215 (LA–11772-MS) **Experiments in finding neural network weights.** Thomas, T.R.; Brewster, T.L. Los Alamos National Lab., NM (USA). Apr 1990. 10p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90007696. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report compares the speed with which back-propagation, conjugate gradient, and Quickprop algorithms find the neural network weights that solve: a small-scale nonlinear classification problem and a mapping from a vector-valued time series to a one-dimensional signal. The problem of tuning each algorithm for these problems (i.e., selecting a good set of control parameters) is also discussed. The most efficient algorithm was found to be an enhanced form of back-propagation using large momentum and learning rates, with weight updates after each pattern presentation and a small constant added to the error derivatives. 3 refs., 6 tabs.

23216 (LAL–88-52) **Use of an IBM -FPS loosely coupled array of processors for high energy physics programs.** Grosdidier, G. Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire. Sep 1988. 25p. Order Number DE90756347. Available from NTIS (US Sales Only), PC A03/MF A01.

An heterogeneous system based on the coupling of an IBM host computer and several FPS attached processors has been set up in the IBM Kingston research center. This system named loosely Coupled Array of Processors, is based on the use of separate processors for parallel processing of nearly independent computing sequences inside the same program. Such a system is well suited to several High Energy Physics applications, for instance Monte Carlo simulation and event reconstruction. One example of each kind has been implemented on this system, and benchmark tests achieved. Speed-up performance figures are given, as well as a comparison with some standard sequential mainframes. The ICAP operating system is discussed from a user's point of view.

23217 (LA-UR–89-2722) **Bulletin: An authoring and change control tool.** Sanders, C.E. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900532–2: 37. international technical communications conference, Santa Clara, CA (USA), 20-23 May 1990). Order Number DE89016592. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Computer Documentation Group at Los Alamos National Laboratory plays an important role in the monthly change control process by documenting network component changes in a publication called the ICN Change Bulletin. BULLETIN is a menu-driven utility used by programmers and computer documentation writers to create articles for the ICN Change Bulletin, which is published in both hardcopy (printed) and softcopy (electronic) forms. BULLETIN also provides information used by other change control software tools. This paper describes the BULLETIN utility and its evolution from a single-purpose authoring tool to a complex, multipurpose authoring and change control tool. 4 refs., 4 figs.

23218 (LA-UR–90-32) **Re-engineering the Los Alamos Common File System.** Christman, R.D.; Cook, D.P.; Mercier, C.W. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-9005105–1: 10. IEEE symposium on mass storage systems, Monterey, CA (USA), 7-10 May 1990). Order Number DE90007887. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Los Alamos National Laboratory's Common File System is being substantially upgraded so it will continue to meet the future data storage needs of the Laboratory and other sites. The nature of computing is changing with the advent of workstations, different work loads, and standard approaches to networking and operating systems. We reviewed the pros and cons of the Common File System and numerous existing and planned systems. Our conclusion was that the Common File System was a valuable resource with many strengths that should be preserved for the future. We have arrived at a set of recommendations for changes and additions that we feel will allow the Common File System to continue to meet data storage needs in both the short and long term. The recommendations for 1990–1992 support the transition to Unix on supercomputers and support high performance networking. The recommendations for 1992–1995 support the transition to a Unix type file system that provides a significant level of file location transparency. For 1995–2000 the recommendations are necessarily less precise but support the notion of standard security, transparent file systems and faster networking. 11 refs.

23219 (LA-UR–90-613) **Using digital halftones in desktop publishing.** Webb, G.W. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900532–3: 37. international technical communications conference, Santa Clara, CA (USA), 20-23 May 1990). Order Number DE90007491. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

I examine the use of black and white scanned digital input of continuous tone images (photographs and some types of artwork) in publications produced on personal computers and give basic information about scanner resolution, gray scales, halftones, and their relation to printer output quality. 1 ref., 8 figs.

23220 (M–285) **ISLE [Image and Signal Processing LISP Environment] reference manual.** Sherwood, R.J.; Searfus, R.M. Lawrence Livermore National Lab., CA (USA). Jan 1990. 97p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90007858. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

ISLE is a rapid prototyping system for performing image and signal processing. It is designed to meet the needs of a person doing development of image and signal processing algorithms in a research environment. The image and signal processing modules in ISLE form a very capable package in themselves. They also provide a rich environment for quickly and easily integrating user-written software modules into the package. ISLE is well suited to applications in which there is a need to develop a processing algorithm in an interactive manner. It is straightforward to develop the algorithms, load it into ISLE, apply the algorithm to an image or signal, display the results, then modify the algorithm and repeat the develop-load-apply-display cycle. ISLE consists of a collection of image and signal processing modules integrated into a cohesive package through a standard command interpreter. ISLE developer elected to concentrate their effort on developing image and signal processing software rather than developing a command interpreter. A COMMON LISP interpreter was selected for the command interpreter because it already has the features desired in a command interpreter, it supports dynamic loading of modules for customization purposes, it supports run-time parameter and argument type checking, it is very well documented, and it is a commercially supported product. This manual is intended to be a reference manual for the ISLE functions The functions are grouped into a number of categories and briefly discussed in the Function Summary chapter. The full descriptions of the functions and all their arguments are given in the Function Descriptions chapter. 6 refs.

23221 (PB–90-130253/XAB) **Supercomputers need super arithmetic. Final report.** Lozier, D.W.; Turner, P.R. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Applied and Computational Mathematics Div. Oct 1989. 31p. (NISTIR–89/4135). Available from NTIS, PC A03/MF A01.

This paper discusses the parallel computation of vector norms and inner products in floating-point for vector and parallel computers. It concentrates on the vectorization of algorithms for the operations and proposes a new form of computer arithmetic, the symmetric level-index system.

23222 (PB–90-131228/XAB) **High-performance computing and networking for science. Background paper.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Sep

1989. 52p. (OTA-BP-CIT–59). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600758.

The background paper explores key issues concerning the Federal role in supporting national high-performance computing facilities and in developing a national research and education network.

23223 (PB–90-856337/XAB) **Supercomputers. December 1985-January 1988 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for December 1985-January 1988.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 231p. Available from NTISPC N01/MF N01.

See also PB–90-856345.

This bibliography contains citations concerning the development and utilization of supercomputers. The citations include references to algorithms for specific applications and machines, architecture considerations, and problem-solving applications using these very fast computers. Machine development in the U.S. and foreign countries is discussed. (This updated bibliography contains 434 citations, none of which are new entries to the previous edition.)

23224 (PB–90-856345/XAB) **Supercomputers. February 1988-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for February 1988-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 244p. Available from NTISPC N01/MF N01.

Supersedes PB–88-857081. See also PB–90-856337.

This bibliography contains citations concerning the development and utilization of supercomputers. The citations include references to algorithms for specific applications and machines, architecture considerations, and problem-solving applications using these very fast computers. Machine development in the U.S. and foreign countries is discussed. (This updated bibliography contains 450 citations, all of which are new entries to the previous edition.)

23225 (PB–90-856378/XAB) **Transputers and the occam programming language. January 1975-October 1988 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-October 1988.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 144p. Available from NTISPC N01/MF N01.

See also PB–90-856386.

This bibliography contains citations concerning the Inmos Transputer and the OCCAM programming language, also developed by Inmos. A transputer is a high performance 32-bit computer on a chip, complete with interfaces and memory. It has been designed as a building block component for use in parallel-processing networks. The OCCAM language is used in a multiprocessor environment to direct data flow and processor communication. Citations are included that discuss theory, practical applications, and case studies. (This updated bibliography contains 328 citations, none of which are new entries to the previous edition.)

23226 (PB–90-856386/XAB) **Transputers and the OCCAM programming language. November 1988-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for November 1988-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 61p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870423. See also PB–90-856378.

This bibliography contains citations concerning the Inmos Transputer and the OCCAM programming language, also developed by Inmos. A transputer is a high performance 32-bit computer on a chip, complete with interfaces and memory. It has been designed as a building block component for use in parallel-processing networks. The OCCAM language is used in a multiprocessor environment to direct data flow and processor communication. Citations are included that discuss theory, practical applications, and case studies. (This updated bibliography contains 97 citations, all of which are new entries to the previous edition.)

23227 (SAND–89-1482) **A scheme for running batch jobs interactively from menu-driven INGRES programs.** Vopicka, D.A. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 22p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90008134. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents a method of running batch jobs from menu-driven interactive EQUEL programs. EQUEL is the embedded query language of INGRES, a popular database management system used widely at Sandia. The method is framed in the VAX/VMS operating system environment.

23228 (SAND–89-2670C) **On the classification of ideal secret sharing schemes.** Brickell, E.F.; Davenport, D.M. Sandia National Labs., Albuquerque, NM (USA). 2 Nov 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8908215–1: Crypto '89, Santa Barbara, CA (USA), 12 Aug 1989). Order Number DE90008739. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In a secret sharing scheme, a dealer has a secret key. There is a finite set P of participants and a set Γ of subsets of P. A secret sharing scheme with Γ as the access structure is a method which the dealer can use to distribute shares to each participant so that a subset of participants can determine the key if and only if that subset is in Γ. The share of a participant is the information sent by the dealer in private to the participant. A secret sharing scheme is ideal if any subset of participants who can use their shares to determine any information about the key can in fact actually determine the key, and if the set of possible shares is the same as the set of possible keys. In this paper, we show a relationship between ideal secret sharing schemes and matroids. 9 refs.

23229 (SAND–90-0052C) **RIPE: An object-oriented Robot Independent Programming Environment.** Miller, D.J.; Lennox, R.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004148–1: USENIX C++ conference, San Francisco, CA (USA), 9-11 Apr 1990). Order Number DE90008501. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An object-oriented Robot Independent Programming Environment (RIPE) developed at Sandia National Laboratories is being used for rapid design and implementation of a variety of applications. A system architecture based on hierarchies of distributed multiprocessors provides the computing platform for a layered programming structure that models the application as a set of software objects. These objects are designed to support model-based automated planning and programming, real-time sensor-based activity, error handling, and robust communication. The object-oriented paradigm provides mechanisms such as inheritance and polymorphism which allow the implementation of the system to satisfy the goals of software, reusability, extensibility, reliability, and portability. By designing a hierarchy of generic parent classes and device-specific subclasses which inherit the same interface, a Robot Independent Programming Language (RIPL) is realized. Work cell tasks demonstrating robotic cask handling operations for nuclear waste facilities are successfully implemented using this object-oriented software environment. 19 refs., 8 figs.

23230 (UCRL–21276) **POSTER user's manual: Version May 1989.** Ludeking, L. (Mission Research Corp., Newington, VA (USA)); Warren, G.; McDonald, J.; Goplen, B. Lawrence Livermore National Lab., CA (USA); Mission Research Corp., Newington, VA (USA). May 1989. 133p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (MRC/WDC-R–166). Order Number DE90008789. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The purpose of this document is to describe the procedures for using the POSTER post processor. This report will discuss the capabilities of POSTER, describe the command structure, and provide examples of the input and output options available. 1 ref., 5 figs., 4 tabs.

23231 (UCRL–101868) **An information-theoretic look at branch-prediction.** Ponder, C.G. (Lawrence Livermore National Lab., CA (USA)); Shebanow, M.C. Lawrence Livermore National Lab., CA (USA). 13 Sep 1989. 26p. Sponsored by University of

California; U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation; State of California. DOE Contract W-7405-ENG-48. CCR-8812843;DAAG29-85-K-0070;N00039-84-C-0089. (CONF-900564–1: Association for Computing Machines (ACM) sigmetrics '90 conference, Boulder, CO (USA), 22-25 May 1990). Order Number DE90001170. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Accurate branch-prediction is necessary to utilize deeply pipelined and Very Long Instruction-Word (VLIW) architectures. For a set of program traces we show the upper limits on branch predictability, and hence machine utilization, for important classes of branch-predictors using static (compiletime) and dynamic (runtime) program information. A set of optimal "superpredictors" is derived from these program traces. These optimal predictors compare favorably with other proposed methods of branch-prediction. 11 refs., 5 figs., 11 tabs.

23232 (UCRL–102046) **Recent advances in 3D finite difference mesh generation using the BRL-CAD package.** Laguna, G.W. Lawrence Livermore National Lab., CA (USA). Sep 1989. 16p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Contract AFWL87-217. (CONF-8910366–1: BRL-CAD symposium '89, Aberdeen, MD (USA), 24-25 Oct 1989). Order Number DE90007854. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

For the past three years Lawrence Livermore National Laboratory has been developing methods for generating 3D finite difference (FD) meshes directly from solid models. During the past year we have changed our solid modeling platform for FD mesh generation from the TIPS-1 solid modeler to the BRL-CAD package. In addition to the basic changes required by the differences between these two modelers and their application interfaces, we have also developed a new strategy for generating the mesh from the sample data. This new approach has dramatically improved the correspondence between generated meshes and the originating geometries. Our new approach also generates mesh elements which are more appropriate for our FD analysis code, TSAR, which calculates edge-based vector unknowns. In the past, edge (wire) mesh elements were approximated from mesh cells, however, we are now able to generate true edge mesh elements in a direct and straightforward manner. The basis of this new approach is a two step process of sampling and filtering which require that each FD mesh cell be subdivided into eight equal-sized octants. By using octants, the mesh generator can sense the configuration of the geometry contained by a cell and assign only those mesh elements which are appropriate to the given configuration. In addition to the above changes, several new features and capabilities have been added which together form a very flexible tool for generating FD meshes. Our mesh generator is currently undergoing internal testing further development. Nonetheless, it has already been used to generate meshes for several projects at LLNL, and users of these meshes have obtained acceptable results. 4 refs., 9 figs.

23233 (UCRL–102663) **The Livermore distributed storage system: Implementation and experiences.** Foglesong, J.; Richmond, G.; Cassell, L.; Hogan, C.; Kordas, J.; Nemanic, M. Lawrence Livermore National Lab., CA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005105–4: 10. IEEE symposium on mass storage systems, Monterey, CA (USA), 7-10 May 1990). Order Number DE90007257. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The LINCS Storage System (LSS) has been in production at Lawrence Livermore National Laboratory since January, 1988. In the development of the LSS, the designers made key architectural decisions which included the separation of data and control messages, a network-wide locking mechanism, and the separation of the naming mechanism from other object managers. Other important issues of the system deal with space management, descriptor management, and system administration. This paper outlines the LSS software system and then focuses on these key design decisions and issues with the intent of providing some insight into the types of difficulties designers face in developing a distributed storage system. 11 refs., 3 figs.

23234 (UCRL–102664) **The Livermore Distributed Storage System: Requirements and overview.** Hogan, C.; Cassell, L.; Foglesong, J.; Kordas, J.; Nemanic, M.; Richmond, G. Lawrence Livermore National Lab., CA (USA). Jan 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005105–2: 10. IEEE symposium on mass storage systems, Monterey, CA (USA), 7-10 May 1990). Order Number DE90007255. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper outlines the requirements for a large-scale, distributed storage system, and describes how a system being developed at the Lawrence Livermore National Laboratory, called the LINCS Storage System (LSS), meets those requirements. The LSS provides distributed storage in an environment that includes supercomputer host machines and a large-capacity, hierarchical central repository. The paper defines the key turns and concepts of the LSS and gives a brief architectural overview of the system. Major system components are described in more detail. The contributions of the LSS to the design of large-scale, distributed storage systems are identified and discussed throughout the paper. Finally, the current status of the development of the LSS is described, including a brief summary of hardware and software components. 18 refs., 8 figs.

23235 (UCRL–102665) **Overcoming Unix kernel deficiencies in a portable, distributed storage system.** Gary, M. Lawrence Livermore National Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005105–3: 10. IEEE symposium on mass storage systems, Monterey, CA (USA), 7-10 May 1990). Order Number DE90007256. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The LINCS Storage System at Lawrence Livermore National Laboratory was designed to provide an efficient, portable, distributed file and directory system capable of running on a variety of hardware platforms, consistent with the IEEE Mass Storage System Reference Model. Our intent was to meet these requirements with a storage system running atop standard, unmodified versions of the Unix operating system. Most of the system components runs as ordinary user processes. However, for those components that were implemented in the kernel to improve performances, Unix presented a number of hurdles. These included the lack of a lightweight tasking facility in the kernel; process-blocked I/O; inefficient data transfer; and the lack of optimized drivers for storage devices. How we overcame these difficulties is the subject of this paper. Ideally, future evolution of Unix by vendors will provide the missing facilities; until then, however, data centers adopting Unix operating systems for large-scale distributed computing will have to provide similar solutions. 11 refs., 5 figs.

23236 **The epsilon dataflow processor.** Grafe, V.G. (Sandia National Labs., Albuquerque, NM (USA)); Davidson, G.S.; Hoch, J.E.; Holmes, V.P. pp. 428 of Proceedings of the 16th annual international symposium on computer architecture. Association for Computing Machinery, New York, NY (1989). DOE Contract AC04-76DP00789. (CONF-890537–: 16. annual international symposium on computer architecture, Jerusalem (Israel), 28 May - 1 jun 1989).

The epsilon dataflow architecture is reported in this paper. It is designed for high speed uniprocessor execution as well as for parallel operation in a multiprocessor system. The epsilon architecture directly matches ready operands, thus eliminating the need for associative matching stores. epsilon also supports low cost data fan out and critical sections. A 10 MFLOPS CMOS/TTL processor prototype is running and its performance has been measured with several benchmarks. The prototype processor has demonstrated sustained performance exceeding that of comparable control flow processors running at higher clock rates.

23237 **Implementation of a 3D thermal analysis code on the CM-2 connection machine computer.** Cline, R.E. Jr. (Sandia National Labs., Livermore, CA (US)); Boghosian, B.M.; Nemnich, B. pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385–: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

This paper describes progress toward the full implementation of a version of TACO3D, a 3D thermal analysis code, for use on the CM-2 connection machine. The authors have implemented a combination of a parallel conjugate gradient solver, which runs on the CM-2, and a serial calling program, which resides on the VAX front-end in order to assess the feasibility of utilizing this type of massively parallel computer in the engineering production environment. Preliminary results show this implementation, running on a 16K processor CM-2, is over 5 times faster than a single XMP processor in the solution of a – 30,000 node 3D application. The authors discuss future plans to complete the optimum implementation of the entire code.

23238 **A parallel particle-in-cell model for the massively parallel processor.** Lin, C.S. (Southwest Research Inst., San Antonio, TX (USA)); Thring, A.L.; Koga, J. pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385–: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

The particle-in-cell model, which has been used extensively on supercomputers to simulate fusion and space plasma phenomena, is difficult to develop for the massively parallel processor (MPP) because the model requires indirect indexing in computing electric fields. To overcome the difficulties, a parallel PIC algorithm is developed for MPP by mapping particles in a cell randomly to a row of processors. Because of this mapping, the algorithm needs only the nearest neighbor communication to sort particles and to collect charge density for each cell. From the cell charge density, this algorithm then calculates electric fields at the cell by fast Fourier transform. The developed PIC code has a speed comparable to that of the vectorized PIC code on Cray X-MP. The results from simulating the plasma instabilities of a cold electron beam in a hot electron background are presented.

23239 **Pipelined data parallel algorithms: Concept and modeling. .** TaKing, C. (Michigan State Univ., East Lansing, MI (USA). Dept. of Computer Science); Chou, W.H.; Wi, L.M. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (1988). DOE Contract W-31-109-ENG-38. (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

A new style of efficient parallel algorithms on distributed-memory multiprocessors is introduced, which exploits parallelism through pipelined parallel computation, or large-grain pipelining. To model pipelined parallel computations, an analytic model is presented, which takes into account both underlying architecture and algorithm behavior. The authors' assert that the resultant model is accurate enough to predict the performance of a given algorithm, and to assist in algorithm designs for determining optimal design parameters such as the granularity. Results from experiments performed on a 64-node NCUBE multiprocessor fare discussed, and a systematic procedure for designing pipelined data parallel algorithms from nested loop programs is described. The impact of the second generation distributed memory multiprocessors on the pipelined parallel computations is also discussed.

23240 **On data synchronization for multiprocessors.** Su, H.M. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development); Yew, P.C. pp. 428 of Proceedings of the 16th annual international symposium on computer architecture. Association for Computing Machinery, New York, NY (1989). (CONF-890537–: 16. annual international symposium on computer architecture, Jerusalem (Israel), 28 May - 1 jun 1989).

As the grain size becomes smaller, more parallelism can be found in most programs. However, to exploit smaller grain parallelism, more efficient synchronization primitives are needed to reduce the increased synchronization overhead. The granularity of parallelism that can be exploited on a multiprocessor system depends heavily on the type and the efficiency of the synchronization supported by the system. For medium-grain parallelism, ordered dependences such as data dependences and control dependences need to be enforced in order to guarantee the correctness of the parallel execution. Hence, data synchronization is one of the major sources of synchronization overhead in the program execution. In this paper, the authors classify the synchronization schemes based on how synchronization variables are used. A scheme, the process-oriented scheme, is proposed. It requires a very small number of synchronization variables and can be supported efficiently by simple hardware in the system.

23241 **Simulation and analysis of enhanced switch architectures for interconnection networks in massively parallel shared memory machines.** Liu, Y.S. (Ultracomputer Research Lab., Courant Institute of Mathematical Sciences, New York Univ., NY (US)); Dickey, S. pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385–: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

Differences in switch architecture can have a significant effect on both latency and throughout in interconnection networks. The authors assess improvements in performance which can be obtained by adding buffers to a crossbar switch, by changing the configuration of the buffers, and by adding the capability of combining messages to the buffers. Four basic k x k crossbar switch types are described: unbuffered, k-input buffers, one per output port; one-input buffers, one per input port; and one-input buffers, k buffers per output port. The authors review previous analytical work and simulation studies of some of these switch types and extend the analysis to the other types. An analytical model for simple hot spot traffic is presented and simulation results are shown for different kinds of message combining.

23242 **Regular processor arrays.** Malony, A.D. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development). pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385–: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

Regular is a term used to suggest simple and uniform structure of a parallel processor's organization or a parallel algorithms's operation. In this paper, the authors define regularity for processor array structures in two dimensions and enumerate the eleven distinct regular topologies. Space and time emulation schemes among the regular processor arrays are constructed to compare their geometric and performance characteristics. The hexagonal array is shown to have the most efficient emulation capabilities.

23243 **Dense symmetric networks from linear groups.** Campbell, L. (Computer Science Dept., Univ. of Idaho (US)); Fellows, M.; Carlsson, G.; Faber, V.; Moore, J.; Langston, M.; Mullhaupt, A. pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385–: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

An algebraic approach to the problem of constructing large networks of bounded degree and diameter is described. Subgroups of GL(2,n) are employed to provide a number of recordbreaking constructions in the range of potential engineering significance for massive networks. These constructions, all highly symmetric, can be viewed as belonging to a family of constructions based on vector spaces and their automorphism groups that include hypercubes and cube-connected cycles as special cases.

23244 **An evaluation of Cray-1 and Cray X-MP performance on vectorizable Livermore Fortran Kernels.** Tang, J. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development); Davidson, E.S. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (1988). (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

This paper studies the impact of the architecture features of the Cray-1 and the Cray X-MP and related compiler optimizations on machine performance. The authors develop a methodology for evaluating the effectiveness of the Cray Fortran compilers in coping with the architectural features and limitations of the Cray-1 and the Cray X-MP. As examples, the effects of vector register reservation and vector index misalignment on the performance of Livermore Fortran Kernels (LFKs) are presented. The causes of the performance differences of two Cray Fortran compilers,

CFT1.14 and CFT77.13, on the vectorized LFKs are described and some areas for further improvement are suggested.

23245 **An optimally portable SIMD programming language.** Tuck, R. (Computer Science Dept., Duke Univ. and Computer Science Dept., Univ. of North Carolina at Chapel Hill, NC (US)). pp. 737 of Proceedings of the 2nd symposium on the frontiers of massively parallel computation. IEEE Service Center, Piscataway, NJ (1988). (CONF-8810385--: 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988).

Existing programming languages for SIMD (single-instruction multiple-data) parallel computers make implicit architectural assumptions. These limit each language to architectures satisfying its assumptions. This paper presents a theoretical foundation for developing much more portable languages for SIMD computers. It also describes work in progress on the design and implementation of such a language. An optimally portable programming language for a set of architectures is one which allows each program to specify the subset of those architectures on which it must be able to run, and which then allows the program to exploit exactly those architectural features available on all of the target architectures. The features available on an architecture are defined to be those the architecture can implement with a constant-bounded number of operations. This definition ensures reasonable execution efficiency, and identifies architectural differences which are relevant to algorithm selection. An optimally portable programming language for SIMD computers, called Porta-SIMD is being developed to demonstrate these ideas.

9903 Information Handling

Refer also to citation(s) 21532, 21897, 22725, 22749, 22791, 23147, 23199, 23227

23246 (AD-A-214592/8/XAB) **Optimization techniques for feature extraction in automatic pattern recognition. Final report.** De Figueiredo, R.J. Rice Univ., Houston, TX (USA). Dept. of Electrical Engineering. 31 Oct 1979. 18p. (EE-TR-7910). Available from NTIS, PC A03/MF A01.

Contents include: statistical feature extraction; adaptive estimator of probability density functions; computationally efficient estimators of Bayes risk; structure preserving dimensionality reduction; oil-spill identification; and digital-image processing.

23247 (CONF-900532-4) **Translating training notebooks into Korean and Japanese.** Schmidt, B.J. (ed.). Argonne National Lab., IL (USA). [1990]. 4p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 37. international technical communications conference; Santa Clara, CA (USA); 20-23 May 1990. Order Number DE90007802. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes the translation of training notebooks into Korean and Japanese. The process of defining the project scope and developing specifications is discussed, and some of the more significant considerations and problems are identified. The discussion concludes with an evaluation of how the final product could have been improved.

23248 (CONF-8808222-1) **Economics of energy sources: Data management and information system.** Vaccaro, R.; Trozzi, C.; Sano, A. ENEA, Rome (Italy). Div. Documentazione e Informazione; TECHNE, Rome (Italy). Aug 1988. 7p. (In Italian). From 44. FID conference and congress; Helsinki (Finland); 28 Aug - 1 sep 1988. Order Number DE89761952. Available from NTIS (US Sales Only), PC A02/MF A01.

This work reports on an information system containing historical series in the field of economics of energy sources. Specific problems related to energy data are analyzed together with the general problem of data, information and information systems. In the development of an information system, before logical and physical design, it is essential that the system be analyzed from the point of view of conceptual and organizational design. Referring to ENERGECO, a data base in the fields of energy and economics, developed by Energy Studies Directorate of ENEA, the problem of interface of an information system is discussed. ENERGECO represents the first step in the development of a complete energy information system. In this work, the principal aspects for the planning of a such system are introduced; in particular the structure of energy data is analyzed. A "descriptive scheme", that defines the structure of data, is analyzed for every process (for example, production) and its relative indicators (for example, quantity) in all its elements (energy source, unit, coverage period, coverage area, etc.). Finally, the basis for a decision support system, that allows the user to retrieve data, to use rules for their combination and aggregation and also to use statistical functions and models are set.

23249 (CONF-8908212-1) **Analysis of compact 0-complete trees: A new access method to large databases.** Orlandic, R. (Univerzitet 'Veljko Vlahovic' u Titogradu, Titograd (Yugoslavia)); Pfaltz, J.L. Virginia Univ., Charlottesville, VA (USA). Dept. of Computer Science; Univerzitet 'Veljko Vlahovic' u Titogradu, Titograd (Yugoslavia). [1989]. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER25063. From 7. FCT conference; Szeged (Hungary); Aug 1989. Order Number DE90008394. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Computer representations often lack those "nice properties" which make proofs of correctness and thorough analysis possible. Compact 0-complete trees are among the rare exceptions. They maintain a strong tie with their conceptual counterpart, a special kind of binary trie, which mirrors their properties and behavior. The ability to shift the focus of analysis, as needed, between the conceptual trie structure and the actual representation enables a more flexible and more powerful set of analytical tools. We have used this paradigm in our investigation of compact 0-complete trees, and here we present some results of that research. In particular, we demonstrate correctness of some operations defined on the structure and derive the expected values of those parameters which are critical for the performance of the structure. 4 refs., 7 figs.

23250 (DOE/ER/25063-2) **Implementation of a hypercube database system: Annual report, March 1989-February 1990.** Pfaltz, J.L.; Son, S.H.; French, J.C. Virginia Univ., Charlottesville, VA (USA). Dept. of Computer Science. Feb 1990. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER25063. (UVA-527387/CS90/102). Order Number DE90008440. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This year, as we predicted in our grant renewal proposal, can be fairly called one of "implementation". A great many low-level modules that are needed for any database system, together with functional implementations of various syntactic constructs of ADAMS were coded and tested. Moreover, these were integrated into three basic system components: the language preprocessor, the persistent dictionary, and the run-time system, to create a complete working database system. Representative application programs using persistent ADAMS elements have been written and executed using the system. To be sure, not all of the components work as effectively as we would like. And we have not attained the level of parallelism that we had expected. Because of this we have embarked on a fundamental redesign of the run-time system and some of its component servers as are described in later sections. 25 refs.

23251 (EGG-10617-1066) **A model research archive: Archive and research implications for original records and support documents.** Fisher, W.A. EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Dec 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-891281-1: Scientific and technical information coordinating group meeting, Washington, DC (USA), 10 Dec 1989). Order Number DE90008246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Office of Scientific and Technical Information (OSTI) and the National Technical Information Service (NTIS) maintain a well organized system to classify, store and retrieve reports of DOE funded research. However, there is no practicable automated system that fully addresses the storage, maintenance, and retrieval of information contained in the original research data from which the reports were generated. These data are the records that record the conditions and limits of research projects and the data derived from experiments and tests. They include field notebooks, commentary,

descriptions of instruments used, project officers reports and observations of the biota and the environment. These documents contain significant original research data, much of which cannot be reproduced in a laboratory and some, will never be attempted again. The data are priceless even in their present semi-organized state. However, depending upon the institution having custody, there is considerable danger that many of these records may be lost or deteriorate in time. Then, on increasing occasion, the researcher is often faced with an insurmountable volume of information. The very magnitude of the reports her or she must digest often results in a paucity of information in the midst of plenty. If specific information contained within these records can be preserved and made fully accessible to authorized researchers reflecting upon modern questions, the impact will have scientific, technology transfer, or commercial implications. The data, while priceless, will increase in value and be more likely to be preserved if they can be organized into an information retrievable format. 1 fig.

23252 (LBL–24578) **Physical design of temporal databases.** Gunadhi, H.; Segev, A. Lawrence Berkeley Lab., CA (USA). Jun 1988. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008067. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary focus of research into temporal databases has been on logical data modeling. Yet, the feasibility of implementing such databases depends as much on the development of retrieval and storage structures that are suited to the unique nature of temporal data. In this paper, we discuss the major parameters that impact the physical design and distinguish temporal databases from conventional ones. This is followed by a proposal of structures to support the efficient processing common single-relation temporal queries. 19 refs., 3 figs., 4 tabs.

23253 (LBL–27359) **Currency-based updates to distributed materialized views.** Segev, A.; Fang, W. Lawrence Berkeley Lab., CA (USA). Jun 1989. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900214–2: 6. international conference on data engineering, Los Angeles, CA (USA), 5-9 Feb 1990). Order Number DE90007775. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In currency-based updates, processing a query to a materialized view has to satisfy a currency constraint which specifies the maximum time lag of the view data with respect to a transaction database. Currency-based update policies are more general than periodical, deferred, and immediate updates; they provide additional opportunities for optimization and allow updating a materialized view from other materialized views. In this paper, we present algorithms to determine the source and timing of view updates and validate the resulting cost savings through simulation results. 20 refs.

23254 (LBL–27873) **Categorizing sound for the establishment of source characteristics.** Meng, J.D. Lawrence Berkeley Lab., CA (USA). May 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8910264–3: Asilomar conference on signals, systems and computers, Monterey, CA (USA), 31 Oct - 1 nov 1989). Order Number DE90007069. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An appropriate categorization of orthogonal parameters of naturally produced (not electronically synthesized) sound based on correlations between producer characteristics and parameters of the received signal can speed the unambiguous identification of the sources of received sounds. Orthogonal parameters of the received signal are the frequency content of its carrier, the amplitude of its envelope and time dependent variations of both. Natural sound sources are objects or cavities or fluids stimulated by modulating devices or rotating devices, or by rapid changes in temperature or pressure. In this paper, we attempt to relate the modulating device and its transmitting operand to unique distinguishing characteristics of the resulting sounds, and to categorize received sound characteristics in a way which permits unambiguous identification of the source. 2 refs., 7 figs., 1 tab.

23255 (UCID–21679-Rev.1) **CALS [Computer-aided Acquisition and Logistic Support] Test Network information exchange user's manual: Revision 1.** Lawrence Livermore National Lab., CA (USA). 22 Dec 1989. 18p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN–89-007). Order Number DE90008119. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The DoD Computer-aided Acquisition and Logistic Support (CALS) Test Network is conducting tests of the military standard for the Automated Interchange of Technical Information (MIL-STD-1840A) and its companion suite of military specifications. The CTN is a DoD-sponsored confederation of voluntary participants from industry and government, managed jointly by a technical staff at Air Force Logistics Command (AFLC) and Lawrence Livermore National Laboratory (LLNL). The objective of CTN tests is to demonstrate and evaluate the interchange and functional use of digital data information between industry and government using the CALS standards. The CTN Information Exchange (CTN Info-X) is a combination of information services for participants and sponsors of the work of the CALS Test Network. This manual tells how to access and use the CALS Info-X.

23256 (UCRL–100992) **A real-time parallel pipelined data-flow image-processing system.** Priatko, G.J.; Andersen, R.W. Lawrence Livermore National Lab., CA (USA). 1 May 1989. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. (CONF-891087–14: IEEE nuclear science symposium and exhibits, San Francisco, CA (USA), 25-27 Oct 1989). Order Number DE90008324. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Until recently, using real-time image processing has been limited because of the expense and complexity of the processing systems. In general, image processing requires both high processor and communications bandwidths. This is particularly true when designing a real-time system that must be capable of handling multiple simultaneous images. Recent developments in both digital technology and system architecture have resulted in the potential for creating low-cost high-performance systems. A common dilemma faced by system architects when designing a real-time image processing system is the need to balance performance against ease of implementation. Several strategies have evolved in an attempt to strike this balance. A common solution is to perform the computationally intensive tasks in special-purpose hardware and the higher-level tasks in software. In practice, this frequently results in a system that is limited by the bandwidth between the general-purpose hardware and the special- purpose hardware. This condition is often referred to as the I/O (input/output) bottleneck. In this paper we present a system that incorporates a highly modular task-specific hardware and software architecture. This architecture enables us to divide the tasks between high bandwidth processing elements and general-purpose workstations. An I/O bottleneck is avoided by including both high-and low-level processing elements and multiple high bandwidth buses within the image processor. This architecture produces a system that enables us to perform most of the imaging tasks within the image processor. In addition, our architecture provides efficient task partitioning. By separating the processing, display, and user interface functions, we can use different hardware and software platforms in different sections of the system. This enhances our ability to optimize, maintain, and upgrade the overall system. 2 figs.

23257 (UCRL–102827) **Toward the virtual classroom.** Pihlman, M.; Dirks, D.H. Lawrence Livermore National Lab., CA (USA). 3 Jan 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900297–1: 1990 American Society for Engineering education conference, Lake Buena Vista, FL (USA), 5-9 Feb 1990). Order Number DE90008304. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) encourages its employees to remotely attend classes given by Stanford University, University of California at Davis, and the National Technological University (NTU). To improve the quality of education for LLNL employees, we are cooperating with Stanford University in upgrading the Stanford Instructional Television Network (SITN). A dedicated high-speed communication link (TI) between Stanford and LLNL will be used for enhanced services such as videoconferencing, real time classnotes distribution, and electronic distribution

of homework assignments. The new network will also allow students to take classes from their offices with the ability to ask the professor questions via an automatically dialed telephone call. As part of this upgrade, we have also proposed a new videoconferencing based classroom environment where students taking remote classes would feel as though they are attending the live class. All paperwork would be available in near real time and students may converse normally with, and see, other remote students as though they were all in the same physical location. We call this the "Virtual Classroom." 1 ref., 6 figs.

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	15:22121	LBL-PUB–3078
	15:22150	LBL–28263
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	15:22880	LBL–91-Rev.-9/89
	15:22892	LBL–28112
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	15:23196	LBL–28101
	15:23252	LBL–24578
	15:23253	LBL–27359
	15:23254	LBL–27873
	Lawrence Livermore National Lab., CA (USA)	
	15:22119	LBL–28294
	15:21572	Published article
	15:21875	Published article
	15:22031	Published article
	15:22161	Published article
AC03-76SF00515	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:22362	SLAC-PUB–5190
	15:22397	SLAC-CN–374
	15:22398	SLAC-PUB–5129
	15:22399	SLAC-PUB–5187
	15:22980	SLAC-PUB–5189
AC03-89ER51114	**Lawrence Livermore National Lab., CA (USA)**	
	15:23073	UCRL–21233
AC04-76DP00656	**General Electric Co., Largo, FL (USA). Neutron Devices Dept.**	
	15:22322	GEPP-TIS–1168
AC04-76DP00789	**Sandia National Labs., Albuquerque, NM (USA)**	
	15:21140	SAND–89-2399
	15:21205	SAND–89-2297C
	15:21620	SAND–89-2236C
	15:21884	SAND–89-3039
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	15:22186	SAND–89-2696C
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	15:23200	SAND–89-2700C
	15:23227	SAND–89-1482
	15:23228	SAND–89-2670C
	15:23229	SAND–90-0052C
	15:21621	SAND–89-7041
	15:22128	SAND–89-7096
	Pacific Northwest Lab., Richland, WA (USA)	
	15:21850	SAND–88-1465
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:21847	NUREG/CR–5405
	15:21848	NUREG/CR–5476
	Wattsun Corp., Albuquerque, NM (USA)	
	15:21619	NMRDI–2-77-5609
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research	
	15:21845	NUREG/CR–5316
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management	
	15:21511	NUREG/CR–5256
	15:21207	Published article
	15:22160	Published article
AC04-76DP03533	**Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant**	
	15:22581	RFP-ENV–88
AC04-76DR00789	**Sandia National Labs., Livermore, CA (USA)**	
	15:22539	SAND–90-8206
AC04-78AL05346	**Westinghouse Electric Corp., Carlsbad, NM (USA). Waste Isolation Div.**	
	15:21530	WAESD-TR–84-0022
AC04-78AL10752	**New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div.**	
	15:21482	EEG–4
	15:21483	EEG–8
	15:21484	EEG–9
	15:21487	EEG–25
	New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group	
	15:21485	EEG–22
AC04-86AL31950	**Westinghouse Electric Corp., Carlsbad, NM (USA). Waste Isolation Div.**	
	15:21530	WAESD-TR–84-0022

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AC04-88DP43495	**EG and G Mound Applied Technologies, Miamisburg, OH (USA)**	
	15:22469	MLM–3628-OP
AC04-89AL58309	**New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Improvement Div.**	
	15:21482	EEG–4
	15:21483	EEG–8
	15:21484	EEG–9
	15:21487	EEG–25
	New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group	
	15:21486	EEG–24
AC04-90DP62349	**Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant**	
	15:21523	RFP–4406
AC05-76OR00001	**Martin Marietta Energy Systems, Inc., Piketon, OH (USA)**	
	15:21445	POEF-T–3508
AC05-76OR00033	**Massachusetts Inst. of Tech., Cambridge, MA (USA)**	
	15:21470	DOE/OR/00033–T436
	Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Nuclear Engineering	
	15:21505	MITNE–281
	Oak Ridge Associated Universities, Inc., TN (USA)	
	15:21969	DOE/OR/00033–T431
	Oak Ridge National Lab., TN (USA)	
	15:22598	DOE/OR/00033–T432
	Michigan Univ., Ann Arbor, MI (USA). Plasma Experimental Lab.	
	15:21570	DOE/OR/00033–T433
AC05-84OR21400	**Oak Ridge National Lab., TN (USA)**	
	15:21117	ORNL/TM–11386
	15:21120	CONF-900562–2
	15:21137	ORNL/M–1081
	15:21456	CONF-900406–40
	15:21457	CONF-900587–1
	15:21514	ORNL/FTR–3535
	15:21515	ORNL/M–1045
	15:21516	ORNL/RASA–89/24
	15:21517	ORNL/RASA–89/25
	15:21518	ORNL/TM–11227
	15:21543	ORNL/RASA–89/21
	15:21544	ORNL/RASA–89/22
	15:21545	ORNL/RASA–89/23
	15:21546	ORNL/RASA–89/26
	15:21669	ORNL/TM–11295
	15:21688	ORNL/FTR–3540
	15:21718	CONF-900418–7
	15:21734	CONF-9004138–1
	15:21781	ORNL/M–898
	15:21789	CONF-9003100–1
	15:21946	ORNL/CON–298
	15:21947	ORNL/FTR–3536
	15:22029	ORNL/M–1069
	15:22050	ORNL/TM–11331
	15:22094	ORNL/FMP–89/2
	15:22138	CONF-891119–108
	15:22141	CONF-900393–2
	15:22168	CONF-891119–107
	15:22248	CONF-900559–7
	15:22250	CONF-900559–12
	15:22259	ORNL/FTR–3539
	15:22281	CONF-9004140–1
	15:22285	ORNL/ATD–20
	15:22321	CONF-9004138–2
	15:22453	CONF-8910197–3
	15:22485	ORNL/OMIS–90/1
	15:22509	ORNL/CDIAC–30
	15:22550	ORNL–6608
	15:22551	ORNL–6608/R1
	15:22552	ORNL/M–1029
	15:22590	CONF-8904311–1
	15:22591	CONF-9004144–1
	15:22606	ORNL/M–1030
	15:22607	ORNL/M–1086
	15:22608	ORNL/TM–11010
	15:22749	CONF-8811313–1
	15:22750	CONF-8909210–8
	15:22760	ORNL–6590
	15:22783	ORNL/TM–11421
	15:22850	CONF-8906270–4
	15:22898	CONF-8906270–3
	15:22914	CONF-8909247–6
	15:22920	ORNL/TM–11297/R1
	15:22926	CONF-900147–2
	15:22956	CONF-8909210–6
	15:22957	CONF-8909210–7
	15:22976	CONF-8906270–2
	15:22979	ORNL/TM–11468
	15:22987	CONF-900174–1-Vugraphs
	15:22988	CONF-900288–4
	15:23108	DOE/ER–0313/7
	15:23137	ORNL/FTR–3541
	15:23138	ORNL/FTR–3542
	15:23139	ORNL/TM–11420
	15:23198	CONF-900566–1
	15:23209	CONF-891273–2
	15:23210	CONF-900290–2
	15:22249	CONF-900559–8
	IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.)	
	15:21989	IEA-HPC-WR–2
	Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center	
	15:23063	ORNL/FEDC–89/3
	15:23135	ORNL/FEDC–89/4
	15:23136	ORNL/FEDC–90/2
	Oak Ridge National Lab., TN (USA). Hazwrap Support Contractor Office	
	15:21465	DOE/HWP–89
	Oak Ridge National Lab., TN (USA). Center for Engineering Systems Advanced Research	
	15:22247	CONF-900559–5
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:21700	NUREG/CR–5450
	15:21849	NUREG/CR–5479
	Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data	
	15:21715	NUREG/CR–2000-Vol.9-No.1
	Oak Ridge National Lab., TN (USA). Applied Technology Div.	
	15:23134	ORNL/ATD–28/V2
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Programs	
	15:21840	NUREG/CR–4674-Vol.10
	15:21948	Published article
	15:22163	Published article
	15:22800	Published article
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	15:21133	K/QT–352
	15:22978	K/CSD/TM–90

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	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	15:21450	K/ITP–270
AC05-86OR21548	**Argonne National Lab., IL (USA)**	
	15:21473	DOE/OR/21548–104
	15:21474	DOE/OR/21548–105
	MK-Ferguson Co., St. Charles, MO (USA)	
	15:21471	DOE/OR/21548–063-Rev.1
	15:21472	DOE/OR/21548–066
AC05-86OR21600	**Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center**	
	15:21541	FMPC–2173
	15:21542	FMPC/Sub–018
AC06-76FF02170	**Hanford Engineering Development Lab., Richland, WA (USA)**	
	15:21775	HEDL-TC–1933
AC06-76RL01830	**Pacific Northwest Lab., Richland, WA (USA)**	
	15:21521	PNL–6450-28-HEDR
	15:21522	PNL–7102
	15:21885	PNL–7203
	15:21959	PNL-SA–16902
	15:22156	PNL-SA–17162
	15:22493	PNL-MA–580
	15:22538	PNL-SA–17905
	15:22578	PNL–7116
	15:22706	PNL–7257
	15:22751	DOE/EH–0128
	15:23140	PNL-SA–15704
	15:23141	PNL-SA–16984
	15:23142	PNL-SA–16989
	15:23143	PNL-SA–16990
	15:23144	PNL-SA–16998
	USDOE Bonneville Power Administration, Yakima, WA (USA)	
	15:21603	DOE/BP/01830–4
AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
	15:21531	WHC-EP–0142-3
	15:21532	WHC-MR–0008
	15:21533	WHC-SA–0682
	15:21534	WHC-SA–0715
AC07-76ID01570	**Geological Survey, Idaho Falls, ID (USA)**	
	15:22543	DOE/ID–22085
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:21467	DOE/LLW–13Tg-Rev.2-Vol.1
	15:21468	DOE/LLW–13Tg-Rev.2-Vol.2
	15:21488	EGG-M–89442
	15:21489	EGG-M–89471
	15:21793	EGG-EAST–8829
	15:22792	EGG-M–89247
	15:21791	DOE/ID–10238
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:21841	NUREG/CR–5229-Vol.2
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research	
	15:21842	NUREG/CR–5273-Vol.4
AC07-84ID12435	**Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (USA)**	
	15:22585	WINCO–1071
AC07-88ID12735	**MSE, Inc., Butte, MT (USA)**	
	15:21953	DOE/ID/12735–T6
AC08-88NV10617	**EG and G Energy Measurements, Inc., Las Vegas, NV (USA)**	
	15:23251	EGG–10617-1066
	EG and G Energy Measurements, Inc., Albuquerque, NM (USA). Kirtland Operations	
	15:22790	EGG–10617-6062
	15:22791	EGG–10617-6066
	EG and G Energy Measurements, Inc., Goleta, CA (USA)	
	15:22429	EGG–10617-2051
AC09-76SR00001	**Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.**	
	15:21481	DP–1777
	Savannah River Lab., Aiken, SC (USA)	
	15:21449	DP–1770
AC09-89SR18035	**Savannah River Lab., Aiken, SC (USA)**	
	15:21792	DPST–73-225
	Westinghouse Savannah River Co., Aiken, SC (USA)	
	15:21441	DP–1776
	15:21444	WSRC-RP–89-1100
	15:21451	WSRC-RP–89-981
	15:21547	WSRC-RP–89-1298
AC12-76SN00052	**Knolls Atomic Power Lab., Schenectady, NY (USA)**	
	15:22116	KAPL–4713
AC21-82MC24222	**International Fuel Cells Corp., South Windsor, CT (USA)**	
	15:21956	DOE/MC/24222–2790
	15:22798	Published article
AC21-84MC21181	**Geoexplorers International, Inc., Denver, CO (USA)**	
	15:21353	DOE/MC/21181–1950-Vol.12
	15:21354	DOE/MC/21181–1950-Vol.14
AC21-86MC23257	**Pennsylvania State Univ., University Park, PA (USA)**	
	15:21167	DOE/MC/23257–2801
AC21-87MC23291	**Energy Research Corp., Danbury, CT (USA)**	
	15:21122	DOE/MC/23291–2780
AC22-85BC10846	**Texas Univ., Austin, TX (USA). Dept. of Petroleum Engineering**	
	15:21286	DOE/BC/10846–15
AC22-88PC88810	**National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)**	
	15:21303	DOE/PC/88810–4
AC22-88PC88867	**Southern Research Inst., Birmingham, AL (USA)**	
	15:21660	DOE/PC/88867–T5
AC22-88PC88878	**California State Senate Water Resources Committee, Sacramento, CA (USA)**	
	15:21147	DOE/PC/88878–T5
AC22-88PC88951	**Institute of Gas Technology, Chicago, IL (USA)**	
	15:21149	DOE/PC/88951–3
AC22-89PC89877	**Pennsylvania State Univ., University Park, PA (USA)**	
	15:21126	DOE/PC/89877–1
AC79-85BP23821	**USDOE Bonneville Power Administration, Portland, OR (USA)**	
	15:21965	DOE/BP/23821–2
AI01-77CS51040	**National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center**	
	15:22080	DOE/NASA–0282-1
AI01-86CE50162	**National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center**	
	15:22033	DOE/NASA/50162–3
AI05-82RL10355	**National Optical Astronomy Observatories, Tucson, AZ (USA)**	
	15:22840	DOE/RL/10355–T1

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AI08-86NV10583	Geological Survey, Carson City, NV (USA)	
	15:21528	USGS-OFR-90-105
AI79-84BP14903	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
	15:21604	DOE/BP/14903-2
AS03-81ER40027	Lawrence Berkeley Lab., CA (USA)	
	15:22893	LBL-28196
AS05-79ER10495	Oklahoma Univ., Norman, OK (USA)	
	15:22929	DOE/ER/10495-3
AS05-83ER13053	Oklahoma Univ., Norman, OK (USA)	
	15:21581	DOE/ER/13053-8
	15:22710	DOE/ER/13053-5
AS19-81BC10508	United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre	
	15:21212	CONF-850710-
AS22-80BC10302	Oklahoma State Univ., Stillwater, OK (USA). Dept. of Botany and Microbiology	
	15:21285	DOE/BC/10302-46
BI79-83BP39461	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
	15:21605	DOE/BP/39461-5
BI79-87BP35677	Bonneville Power Administration, Portland, OR (USA)	
	15:22043	DOE/BP/35677-1
FC07-89ID12847	USDOE, Washington, DC (USA)	
	15:22108	DOE/ID/12847-T1
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)	
	15:21288	NIPER-388
	15:21289	NIPER-461
FC79-82BP34625	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management	
	15:21966	DOE/BP/34625-1
	15:21967	DOE/BP/34625-2
FG01-82CE15136	United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre	
	15:21400	CONF-850710-
FG01-83ER60161	National Research Council, Washington, DC (USA). Water Science and Technology Board	
	15:22592	DOE/ER/60161-T1
	15:22593	DOE/ER/60161-T2
	15:22594	DOE/ER/60161-T3
	15:22595	DOE/ER/60161-T4
	15:22596	DOE/ER/60161-T5
FG01-84ER13182	Geological Society of America, Boulder, CO (USA)	
	15:22787	DOE/ER/13182-T1
	Geological Survey, Boulder, CO (USA)	
	15:22788	DOE/ER/13182-T2
FG01-86ER35012	National Research Council, Washington, DC (USA). Committee to Assess Safety and Technical Issues at DOE Reactors	
	15:21790	DOE/ER/35012-T3
FG01-87IE10574	Arkansas Research Consultants, Inc., Fayetteville, AR (USA)	
	15:21202	DOE/IE/10574-T1
FG01-87PE79027	Keystone Center, CO (USA)	
	15:21939	DOE/PE/79027-T1
FG01-89CE15434	Rototherm, Inc., Howell, NJ (USA)	
	15:21968	DOE/CE/15434-T1
FG02-84ER40173	Illinois Univ., Chicago, IL (USA). Dept. of Physics	
	15:22899	DOE/ER/40173-5
FG02-84ER45061	Utah Univ., Salt Lake City, UT (USA)	
	15:22105	DOE/ER/45061-6
FG02-84ER45125	Northwestern Univ., Evanston, IL (USA). Dept. of Physics and Astronomy	
	15:22960	DOE/ER/45125-T2
FG02-84ER45167	Brown Univ., Providence, RI (USA). Div. of Engineering	
	15:22142	DOE/ER/45167-T1
FG02-84ER52111	Illinois Univ., Urbana, IL (USA). Fusion Technology Lab.	
	15:23106	CONF-891007-118
	Illinois Univ., Urbana, IL (USA). Dept. of Electrical and Computer Engineering	
	15:23109	DOE/ER/52111-T6
FG02-85ER13441	Brown Univ., Providence, RI (USA)	
	15:22958	DOE/ER/13441-6
	15:22708	Published article
	15:22709	Published article
FG02-86ER13570	Indiana Univ., Bloomington, IN (USA)	
	15:22221	DOE/ER/13570-4
FG02-86ER13592	Dartmouth Coll., Hanover, NH (USA). Dept. of Chemistry	
	15:22229	DOE/ER/13592-T2
FG02-86ER25015	Massachusetts Univ., Amherst, MA (USA)	
	15:23211	DOE/ER/25015-29
FG02-86ER40264	Pennsylvania Univ., Philadelphia, PA (USA)	
	15:22934	DOE/ER/40264-4
FG02-86ER60445	Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry	
	15:22203	DOE/ER/60445-4
FG02-86ER60460	Massachusetts Inst. of Tech., Cambridge, MA (USA)	
	15:22724	DOE/ER/60460-4
FG02-86ER60470	Pennsylvania State Univ., University Park, PA (USA). Environmental Resources Research Inst.	
	15:22597	DOE/ER/60470-1
	15:21144	Published article
	15:21145	Published article
FG02-87ER45303	Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering	
	15:22144	DOE/ER/45303-2
FG02-87ER45310	Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering	
	15:22106	DOE/ER/45310-20
FG02-87ER45323	Boston Univ., MA (USA)	
	15:22961	DOE/ER/45405-1
FG02-87ER60530	Indiana Univ. Foundation, Bloomington, IN (USA)	
	15:21576	DOE/ER/60530-3
FG02-87ER60577	Pennsylvania State Univ., University Park, PA (USA)	
	15:21540	DOE/ER/60577-2
FG02-88ER13862	Minnesota Univ., Navarre, MN (USA). Gray Freshwater Biological Inst.	
	15:21582	DOE/ER/13862-T1
FG02-88ER13937	Columbia Univ., New York, NY (USA)	
	15:22230	DOE/ER/13937-2
FG02-88ER40406	Oak Ridge National Lab., TN (USA)	
	15:22914	CONF-8909247-6
FG02-88ER45362	Rensselaer Polytechnic Inst., Troy, NY (USA)	
	15:22172	DOE/ER/45362-2
FG02-88ER45379	Harvard Univ., Cambridge, MA (USA)	
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FG22-88PC88918	Georgia Inst. of Tech., Atlanta, GA (USA). School of Aerospace Engineering	
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TE-87-10	15:22084	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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89-05643	15:21623	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
BMU–					
1989-212	15:22541	Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.)			
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1989-229	15:22280	Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.)			
1989-230	15:21787	Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.)			
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89-18	15:22744	Available from Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw)			
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43503	15:22784	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008288	MF-403
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52007-Vol.3	15:21837	*See* NUREG/CR–4659-Vol.3			
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89-50	15:22426	NTIS (US Sales Only), PC A04/MF A01		DE90759515	
89-51	15:22427	NTIS (US Sales Only), PC A04/MF A01		DE90759513	
BR–					
85(7.26)	15:22542	NTIS, PC A05/MF A01; OSTI - US Fish and Wildlife Service, 18th and C Streets, N.W., Mail Stop 1111, Arlington Square Building, Washington, DC 20240		TI90007346	
BRE-IP–					
20/89	15:21962	NTIS (US Sales Only), PC A02/MF A01		DE90754402	
CC/W–					
57097A	15:22042	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
KI23410AO	15:22073	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CCREM–					
TS/WM-TREOO3	15:22072	PC Canadian Council of Resource and Environment Ministers, 4905 Dufferin St., Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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02854	15:22781	*See* HAZ–CE02854			
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02873	15:21389	*See* PCCIM–CE02873			
02899	15:21929	*See* NEB-SS–22-1/1989-12E			
02900	15:21930	*See* NEB-SS–22-1/1989-12F			
02901	15:21927	*See* NEB-SS–22-1/1989-11E			
02902	15:21928	*See* NEB-SS–22-1/1989-11F			
02903	15:21336	*See* NEB-SS–22-1/1989-13			
02931	15:21366	*See* NEB–SS-22-1/1989-14E			
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9451	15:23101	NTIS (US Sales Only), PC A03/MF A01		DE90756404	
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9535	15:22986	NTIS (US Sales Only), PC A02/MF A01		DE90756403	
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CEG–					
C212.0002	15:21302	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CEGB-ESTD-L–					
0015/R89	15:21705	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620243	
CEGB-RD-B–					
6032/R88	15:22101	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619375	
6122/R89	15:22747	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619589	
6143/R89	15:22102	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619376	
6173/R89	15:21740	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619680	
6174/R89	15:21706	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620135	
6188/R89	15:22202	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619218	
6210/R89	15:21717	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620126	
CEGB-RD-L–					
3387/R88	15:21724	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620136	
3481/P89	15:22496	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619479	
CEGB-RD-M–					
1789/RR89	15:21725	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620137	
CEGB-TPRD-B–					
1049/R88	15:22103	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619400	
CERI–					
31	15:21313	PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
32	15:21931	PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
CESAR–					
89/41	15:22247	*See* CONF-900559–5			
CLM-R–					
293	15:23105	Available from H.M. Stationery Office, London, price Pound 8.00			
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
COMMUNICATION–					
29	15:22553	*See* PB–90-131657/XAB			
CONF-8309418–		(Workshop on solar and space physics; Hilton Head, SC (USA); 20-23 Sep 1983)			
	15:22808	NTIS, PC A03/MF A01			
CONF-840616–		(31. annual meeting of the Division of Plasma Physics of the American Physical Society; Joint conference of the 6. international conference on plasma physics and on the 6. international congress on plasma waves and plasma instabilities; Anaheim, CA (USA); Lausanne (Switzerland); 13-17 Nov 1989; 27 jun - 3 jul 1)			
26	15:23066	*See* PPPL–2680			
CONF-840887–		(16. international congress on high speed photography and photonics; Strasbourg (France); 27-31 Aug 1984)			
	15:22428	*See* CRN-CPR–84-5			
CONF-860145–		(IAEA technical committee meeting on status, experience, and future prospects for the development of probabilistic criteria; Vienna (Austria); 27-31 Jan 1986)			
	15:21802	*See* IAEA-TECDOC–524			
CONF-8610224–					
	15:21975	*See* IEA-HPC-WR–2			
CONF-8610469–		(Arctic offshore technology conference and exposition; Calgary (Canada); 28-31 Oct 1986)			
	15:22296	*See* PRM–CE02870			
CONF-870656–		(6. Institute of Electrical and Electronic Engineers pulsed power conference; Arlington, VA (USA); 29 Jun - 1 jul 1987)			
	15:22337	IEEE Service Center, 445 Hoes Ln., Piscataway, NJ 08854			
CONF-8709143–					
	15:22985	*See* CEA-CONF–9534			
	15:22986	*See* CEA-CONF–9535			
CONF-8709362–		(4. working meeting on radiation interaction; Leipzig (German Democratic Republic); 21-25 Sep 1987)			
	15:22735	*See* IAEA-R–5462-F			
CONF-8709402–		(The Joliot-Curie 1987 nuclear physics school; Maubuisson (France); 14-18 Sep 1987)			
	15:22938	*See* ISN–87-90			
CONF-8711338–		(8. workshop on laser interaction and related plasma; San Diego, CA (USA); 2-6 Nov 1987)			
	15:22984	*See* CEA-CONF–9533			
CONF-871243–		(Symposium on hot nuclei; College Station, TX (USA); 7-10 Dec 1987)			
	15:22937	*See* IPNO-TH–87-52			
CONF-8802160–		(Ein Gedi workshop on combustion; Ein Gedi (Israel); Feb 1988)			
	15:22246				
CONF-8803253–					
	15:22907	*See* CEA-CONF–9805			
CONF-880378–		(Workshop on the effects of recoil spectrum and nuclear transmutation on the evolution of the microstructure; Lugano (Switzerland); 24-29 Mar 1988)			
3	15:23140	*See* PNL-SA–15704			
CONF-880386–		(International conference on spin-observables of nuclear probes; Telluride, CO (USA); 14-18 Mar 1988)			
	15:22902	*See* LYCEN–88-18			
CONF-8804105–		(4. national space symposium; Colorado Springs, CO (USA); 12-15 Apr 1988)			
2	15:22832	*See* UCRL–98567			
CONF-8804119–		(International workshop on nuclear structure of the zirconium region; Bad Honnef (Germany, F.R.); 24-28 Apr 1988)			
5	15:22931	*See* UCRL–98618			

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CONF-8804121–		(MRS symposia on process diagnostics: materials, combustion, and fusion; Reno, NV (USA); 5-7 Apr 1988)			
	15:23074	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237			
CONF-880417–		(1. international symposium on fusion nuclear technology (ISFNT); Tokyo (Japan); 10-19 Apr 1988)			
	15:23101	*See* CEA-CONF–9451			
	15:23102	*See* CEA-CONF–9452			
	15:23103	*See* CEA-CONF–9482			
	15:23104	*See* CEA-CONF–9483			
CONF-8804323–		(2. workshop on thermal-non-thermal interactions in solar flares; Oxford (UK); 10-14 Apr 1988)			
	15:22827	*See* RAL–89-102			
CONF-880505–		(3. topical meeting on tritium technology in fission, fusion and isotopic applications; Toronto (Canada); 1-6 May 1988)			
	15:22199	*See* CEA-CONF–9633			
CONF-8805352–		(Haztech Canada '88: dangerous goods and hazardous waste management conference; Mississauga (Canada); 10-12 May 1988)			
	15:22781	*See* HAZ–CE02854			
CONF-8805355–		(Cargese School on common trends in statistical physics and field theory; Cargese (France); 24 May - 4 jun 1988)			
	15:22905	*See* CEA-CONF–9778			
	15:22908	*See* CEA-CONF–9813			
CONF-8805361–		(10. South Pacific electrical international convention; Brisbane (Australia); 2-5 May 1988)			
	15:21857	*See* N–90-13596			
CONF-8806101–		(International symposium on heavy ion inertial fusion; Darmstadt (Germany, F.R.); 28-30 Jun 1988)			
12	15:23150	*See* UCRL–98585			
CONF-8806236–		(1. European workshop on hadronic physics in the 1990's with multi-GeV electrons; Seillac (France); 27 Jun - 1 jul 1988)			
	15:22881	*See* CEA-CONF–9797			
CONF-8806456–		(Meeting on fields, strings and critical phenomena: Les Houches (France); 28 Jun - 5 aug 1988)			
	15:22955	*See* CEA-CONF–9816			
CONF-8806459–		(21. national colloquium on physics of atom and electron collisions; Caen (France); 21-24 Jun 1988)			
	15:22218	*See* CEA-CONF–9659			
	15:22847	*See* CEA-CONF–9460			
	15:22848	*See* CEA-CONF–9660			
	15:22849	*See* CEA-CONF–9661			
CONF-880687–		(13. international symposium on discharges and electrical insulation in vacuum; Paris (France); 27-30 Jun 1988)			
	15:22358	*See* CRN-VIV–55/2			
CONF-8808222–		(44. FID conference and congress; Helsinki (Finland); 28 Aug - 1 sep 1988)			
1	15:23248	NTIS (US Sales Only), PC A02/MF A01		DE89761952	
CONF-8808293–		(11. Cracow Summer School; Cracow (Poland); 22-31 Aug 1988)			
	15:22807	*See* CEA-CONF–9815			
CONF-8808294–		(YKIS'88; Kyoto (Japan); 22-26 Aug 1988)			
	15:22975	*See* CEA-CONF–9806			
CONF-880867–		(24. international Rochester conference on high energy physics; Munich (Germany, F.R.); 4-10 Aug 1988)			
	15:22894	*See* LPNHEP–88-11			
CONF-8809173–		(International workshop on reconnection in space plasma; Potsdam (German Democratic Republic); 5-9 Sep 1988)			
2	15:23151	*See* UCRL–98768			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8809411–					
	15:22949	*See* LAL–88-55			
CONF-8809455–		(USER-1 conference; Ostend (Belgium); 6-8 Sep 1988)			
1	15:21996	*See* LBL–26262			
CONF-880969–		(International symposium on metal-hydrogen systems, fundamentals and applications; Stuttgart (Germany, F.R.); 4-9 Sep 1988)			
	15:22162				
CONF-881031–		(8. topical meeting on technology of fusion energy; Salt Lake City, UT (USA); 9-13 Oct 1988)			
78	15:23149	*See* UCRL–98535			
CONF-8810312–		(AUTOTESTCON '88: IEEE international automatic testing conference; Minneapolis, MN (USA); 4-6 Oct 1988)			
2	15:21995	*See* LBL–25429			
CONF-8810482–		(Meeting on Integrable models in quantum field theory and statistical Mechanics; Kyoto (Japan); 17-28 Oct 1988)			
	15:22906	*See* CEA-CONF–9795			
CONF-8810483–		(International conference on modern electrostatics; Beijing (China); 21-25 Oct 1988)			
1	15:22896	*See* UCRL–98805			
CONF-881056–		(19. European conference on laser interaction with matter (ECLIM); Madrid (Spain); 3-7 Oct 1988)			
11	15:23152	*See* UCRL–98806			
CONF-8811278–		(New materials approaches to tribology: theory and applications; Boston, MA (USA); 29 Nov - 2 dec 1988)			
	15:22063				
CONF-8811313–		(2. annual Harshaw TLD user's group meeting; Myrtle Beach, SC (USA); 13-16 Nov 1988)			
1	15:22749	NTIS, PC A03/MF A01; OSTI; INIS		DE90007656	MF-407
CONF-881205–		(Symposium on coal, oil, and gas biotechnology; New Orleans, LA (USA); 5-7 Dec 1988)			
6	15:21595	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007599	
CONF-890103–		(6. symposium on space nuclear power systems; Albuquerque, NM (USA); 9-12 Jan 1989)			
	15:21712	*See* N–90-15030			
CONF-890112–		(International superconductivity application convention; San Francisco, CA (USA); 11-13 Jan 1989)			
1	15:22157	*See* UCRL–100216			
CONF-890142–		(Symposium on lasers and optics; Los Angeles, CA (USA); 15-20 Jan 1989)			
6	15:23153	*See* UCRL–99094			
CONF-890157–		(2. conference on high power and solid state lasers; Los Angeles, CA (USA); 19-20 Jan 1989)			
	15:22336	SPIE Society of Photo-Optical Instrumentation Engineers, 1022 19 St., P.O. Box 10, Bellingham, WA 98227			
CONF-8902101–		(IAEA technical committee meeting on impurity control; Naka (Japan); 13-15 Feb 1989)			
	15:22998	*See* IAEA-TECDOC–536			
CONF-8902107–		(School on nuclear matter and heavy ion collisions; Les Houches (France); 7-16 Feb 1989)			
1	15:22893	*See* LBL–28196			
CONF-8902158–		(Conference on global warming: a Northwest perspective; Olympia, WA (USA); 9 Feb 1989)			
1	15:22538	*See* PNL-SA–17905			
CONF-8902168–		(21. lecture meeting of the DVM Study Group on francture mechanisms: fracture-mechanical characteristics for structural components evaluation; Bad Nauheim (Germany, F.R.); 27-28 Feb 1989)			
	15:22112	*See* GKSS–89/E/22			

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CONF-890236–		(13. annual conference on energy from biomass and wastes; New Orleans, LA (USA); 13-17 Feb 1989)			
4	15:21580	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007586	
CONF-8903169–		(3. Society for Industrial and Applied Mathematics (SIAM) conference on domain decomposition methods; Houston, TX (USA); 20-22 Mar 1989)			
3	15:22876	*See* UCRL–99707			
CONF-8903197–		(Symposium on Asian natural gas - a new era; Singapore (Singapore); 6-9 Mar 1989)			
2	15:21371	OSTI - Institute of Gas Technology, 3424 S. State Street, Chicago, IL 60616		TI90007232	
CONF-8903199–		(Oxidation and mechanical properties conference; London (UK); 15 Mar 1989)			
	15:21706	*See* CEGB-RD-B–6174/R89			
CONF-8903201–		(2. KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons; Tsukuba (Japan); 11 Mar 1989)			
	15:22947	*See* KEK–89-13			
CONF-890325–		(8. international conference and exhibition on offshore mechanics and arctic polar engineering (OMAE-8); The Hague (Netherlands); 19-23 Mar 1989)			
	15:22115	*See* GKSS–89/E/31			
CONF-890335–		(13. particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
	15:22395	*See* NIKHEF-K-AmPS–89-03			
CONF-890346–		(1989 oil heat technology conference and workshop; Upton, NY (USA); 27-28 Mar 1989)			
	15:22041	*See* BNL–52217			
CONF-8904311–		(1. international environmetrics conference; Cairo (Egypt); 3-7 Apr 1989)			
1	15:22590	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006147	MF-402
CONF-8904325–		(9. German-Yugoslav meeting on materials sciences and development; Hirsau (Germany, F.R.); 16-19 Apr 1989)			
	15:22147	*See* Juel-Conf–77			
CONF-8905144–		(Tau-Charm Factory workshop; Stanford, CA (USA); 23-27 May 1989)			
15	15:22903	*See* UIUC-HEPG–89-17			
CONF-8905159–					
	15:23146	*See* Rijnhuizen-report–89-186			
CONF-8905179–		(8. Pfefferkorn conference on fundamental beam interactions with solids for microscopy, microanalysis and microlithography; Park City, UT (USA); 7-12 May 1989)			
3	15:22104	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007803	MF-404
CONF-8905227–		(International conference on radiosurgery a neurosurgical approach to intracranial lesions; Charlottesville, VA (USA); 1-5 May 1989)			
5	15:22730	*See* LBL–28254			
6	15:22729	*See* LBL–28253			
7	15:22731	*See* LBL–28255			
CONF-8905289–		(Workshop on few-body systems; Ibaraki (Japan); 22-24 May 1989)			
	15:22921	*See* RCNP-P–106			
CONF-890549–		(21. offshore technology conference and exhibition (OTC-21); Houston, TX (USA); 1-4 May 1989)			
	15:22113	*See* GKSS–89/E/28			
	15:22114	*See* GKSS–89/E/29			
CONF-890572–		(1. annual fuel cells contractors review meeting; Morgantown, WV (USA); 2-4 May 1989)			
2	15:21959	*See* PNL-SA–16902			
CONF-8906139–		(31. weapons agencies nondestructive testing organization; Kansas City, MO (USA); 5-9 Jun 1989)			
2	15:22472	*See* UCRL–102632			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8906204–		(International symposium on heavy quark physics; Ithaca, NY (USA); 13-17 Jun 1989)			
7	15:22897	*See* UIUC-HEPG–89-18			
CONF-8906210–		(Workshop on B-factories and related physics issues; Blois (France); 26 Jun - 1 jul 1989)			
5	15:22370	*See* LBL–27676			
CONF-8906269–		(1989 international symposium on in vivo body composition studies; Toronto (Canada); 20-23 Jun 1989)			
6	15:22722	*See* BNL–43714			
CONF-8906270–		(Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989)			
2	15:22976	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008403	MF-413
3	15:22898	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008404	MF-413
4	15:22850	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008491	MF-411
CONF-8906281–		(Newfoundland offshore: project issues; St. John's (Canada); 6-8 Jun 1989)			
	15:21291	*See* NOIA–89-05124			
CONF-8906289–		(Department of Energy Hazardous Waste Remedial Actions Program (HAZWRAP) Technology Demonstration Program waste site review and ranking meeting; Oak Ridge, TN (USA); 21-23 Jun 1989)			
Summ.	15:21465	*See* DOE/HWP–89			
CONF-8906294–		(Workshop on the standard model at present and future accelerator energies; Budapest (Hungary); 27 Jun - 21 jul 1989)			
1	15:22892	*See* LBL–28112			
CONF-8906298–		(International workshop on proton and narrow photon beam therapy; Oulu (Finland); 8-10 Jun 1989)			
1	15:22726	*See* LBL–28249			
2	15:22727	*See* LBL–28250			
CONF-8906299–		(Workshop on materials issues in circulating fluidized-bed combustors; Argonne, IL (USA); 19-23 Jun 1989)			
	15:21169	*See* EPRI-GS–6747			
CONF-8906301–		(3. workshop on Wendelstein VII-X; Schloss Ringberg (Germany, F.R.); 26-30 Jun 1989)			
	15:23022	*See* IPP–2/302			
CONF-890666–		(9. annual gasification and gas stream cleanup systems contractors review meeting; Morgantown, WV (USA); 27-29 Jun 1989)			
Vol.1	15:21123	*See* DOE/METC–89/6107-Vol.1			
Vol.2	15:21124	*See* DOE/METC–89/6107-Vol.2			
CONF-8907134–		(17. SLAC summer institute: physics at the 100 GeV mass scale; Stanford, CA (USA); 10-21 Jul 1989)			
6	15:22362	*See* SLAC-PUB–5190			
CONF-890718–		(International conference on materials and mechanisms of superconductivity - high-temperature superconductors II; Stanford, CA (USA); 23-28 Jul 1989)			
34	15:22973	*See* UCRL–101287			
35	15:22333	*See* UCRL–100480			
CONF-8907185–		(52. annual meeting of the meteoritical society; Vienna (Australia); 31 Jul - 4 aug 1989)			
	15:22822	*See* N–90-14998			
CONF-890802–		(7. synchrotron radiation instrumentation (SRI) national conference; Berkeley, CA (USA); 6-10 Aug 1989)			
23	15:22359	*See* LBL–27603			
24	15:22420	*See* LBL–27812			
CONF-8908158–		(Conference on microscopic simulation of complex flows; Brussels (Belgium); 21-25 Aug 1989)			
3	15:22276	*See* UCRL–102966			
CONF-8908212–		(7. FCT conference; Szeged (Hungary); Aug 1989)			
1	15:23249	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008394	MF-405

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8908213–		(Workshop on role of plasmas in accelerators; Tsukuba (Japan); 21 Aug 1989)			
	15:23055	*See* KEK–89-14			
CONF-8908215–		(Crypto '89; Santa Barbara, CA (USA); 12 Aug 1989)			
1	15:23228	*See* SAND–89-2670C			
CONF-890826–		(International nuclear physics and cosmology conference; Sao Paulo (Brazil); 20-26 Aug 1989)			
	15:22818	*See* N–90-14167			
CONF-890836–		(33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering; San Diego, CA (USA); 6-11 Aug 1989)			
23	15:22454	*See* UCRL–101541			
CONF-890872–		(Workshop on physics at Fermilab in the 1990's; Breckenridge, CO (USA); 15-24 Aug 1989)			
6	15:22883	*See* FNAL/C–90/39			
CONF-8909107–		(ECFA study week on instrumentation technology for high luminosity hadron colliders; Barcelona (Spain); 14-21 Sep 1989)			
	15:22396	*See* RAL–89-112			
CONF-8909113–		(14. international pyrotechnics seminar; Jersey (UK); 18-22 Sep 1989)			
7	15:22470	*See* SAND–90-0259C			
CONF-8909163–		(5. symposium on containment of underground nuclear detonations; Santa Barbara, CA (USA); 19-21 Sep 1989)			
13	15:22478	*See* UCRL–100962			
14	15:22477	*See* UCRL–100934			
CONF-890920–		(14. international conference on organic geochemistry; Paris (France); 18-22 Sep 1989)			
3-Rev.1	15:21429	*See* UCRL–99776-Rev.1			
CONF-8909210–		(12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989)			
6	15:22956	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008406	MF-411
7	15:22957	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008410	MF-410
8	15:22750	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008747	MF-408
CONF-8909244–		(International heavy particle therapy workshop; Villigen (Switzerland); 18-20 Sep 1989)			
2	15:22728	*See* LBL–28251			
CONF-8909247–		(ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989)			
6	15:22914	NTIS, PC A03/MF A01; OSTI; INIS		DE90007886	MF-413
CONF-8909249–		(Lattice '89 international workshop; Capri (Italy); 18-21 Sep 1989)			
11	15:22901	*See* FNAL/C–89/265-T			
CONF-8909300–		(International school on nuclear physics, neutron physics and nuclear energy conference; Varna (Bulgaria); 29 Sep - 7 oct 1989)			
2	15:22944	*See* UCRL–102923			
CONF-8909306–		(Materials Research Society conference; Boston, MA (USA); 27-30 Sep 1989)			
1-Rev.1	15:21525	*See* UCRL–100952-Rev.1			
CONF-8909307–		(NATO advanced research workshop on conjugated polymeric materials: opportunities in electronics, optoelectronics, and molecular electronics; Mons (Belgium); 3-8 Sep 1989)			
1	15:22166	*See* BNL–43851			
CONF-890953–		(International conference on the physics of highly correlated electron systems; Santa Fe, NM (USA); 11-15 Sep 1989)			
	15:22967	*See* RAL–89-107			
CONF-890996–		(Sensor's expo '89; Cleveland, OH (USA); 12-14 Sep 1989)			
	15:22463	*See* N–90-13761			
CONF-891007–		(13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989)			
118	15:23106	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008773	MF-420

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-891008–		(International symposium on safety assessment of radioactive waste repositories; Paris (France); 9-12 Oct 1989)			
5	15:21498	*See* LBL–27401			
CONF-8910120–		(1. international ceramic science and technology congress; Anaheim, CA (USA); 31 Oct - 3 nov 1989)			
8	15:22127	*See* SAND–89-1514C			
9	15:22156	*See* PNL-SA–17162			
CONF-8910197–		(SPIE symposium on microelectronic integrated processing: growth, monitoring, and control; Santa Clara, CA (USA); 8-13 Oct 1989)			
3	15:22453	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007658	MF-404
CONF-891020–		(Annual conference and exhibition of the Water Pollution Control Federation; San Francisco, CA (USA); 15-19 Oct 1989)			
	15:22181	*See* N–90-14108			
CONF-8910222–		(17. water reactor safety information meeting; Rockville, MD (USA); 23-25 Oct 1989)			
16	15:21788	*See* BNL-NUREG–43069			
CONF-8910255–		(International workshop on severe accidents and their consequences; Sochi City (USSR); 30 Oct - 3 nov 1989)			
Summ.	15:21793	*See* EGG-EAST–8829			
CONF-8910264–		(Asilomar conference on signals, systems and computers; Monterey, CA (USA); 31 Oct - 1 nov 1989)			
3	15:23254	*See* LBL–27873			
CONF-891028–		(12. world energy engineering congress; Atlanta, GA (USA); 25-28 Oct 1989)			
1	15:21999	*See* LBL–27315			
CONF-8910302–		(Symposium on high temperature and materials chemistry; Berkeley, CA (USA); 24-25 Oct 1989)			
1	15:22241	*See* LBL–27905			
CONF-8910313–		(NSF/EPRI workshop on anomalous effects in deuterated materials; Washington, DC (USA); 16-18 Oct 1989)			
3	15:22982	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007641	MF-414
CONF-8910338–		(14. annual climate diagnostics workshop; San Diego, CA (USA); 16-20 Oct 1989)			
2	15:22796	*See* UCRL–102861			
CONF-8910344–		(Kent M. Terwilliger Memorial symposium; Ann Arbor, MI (USA); 13 Oct 1989)			
2	15:22379	*See* BNL–43939			
CONF-8910353–		(14. international conference on infrared and millimeter waves; Wuerzburg (Germany, F.R.); 2 Oct 1989)			
	15:22325	*See* LRP–386/89			
CONF-8910360–		(15. annual Frederick Stohlman Jr., M.D. memorial symposium; Cambridge, MA (USA); 15-20 Oct 1989)			
1	15:22745	*See* BNL–43715			
CONF-8910364–		(International technology exchange program conference; Mito (Japan); 17-20 Oct 1989)			
1	15:21488	*See* EGG-M–89442			
CONF-8910366–		(BRL-CAD symposium '89; Aberdeen, MD (USA); 24-25 Oct 1989)			
1	15:23232	*See* UCRL–102046			
CONF-8910368–		(4. District No.5 meeting; Calgary (Canada); Oct 1989)			
	15:21389	*See* PCCIM–CE02873			
CONF-8910369–		(11. Workshop on ceramic coatings for wear and thermal applications; Edmonton (Canada); 16 Oct 1989)			
	15:22151	*See* N–90-13636			
CONF-8910371–		(Australian aeronautical conference; Melbourne (Australia); 9-11 Oct 1989)			
	15:22123	*See* N–90-14641			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-891043–		(SNEAP '89: symposium on northeastern accelerator personnel; Oak Ridge, TN (USA); 22-27 Oct 1989)			
3	15:22380	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007794	MF-414
CONF-891044–		(1. international conference on radioactive nuclear beams; Berkeley, CA (USA); 16-18 Oct 1989)			
7	15:22372	*See* LBL–28114			
8	15:22401	*See* UCRL–102294			
CONF-891055–		(5. international symposium on the production and neutralization of negative ions and beams; Upton, NY (USA); 30 Oct - 3 nov 1989)			
14	15:22377	*See* BNL–43880			
CONF-891087–		(IEEE nuclear science symposium and exhibits; San Francisco, CA (USA); 25-27 Oct 1989)			
14	15:23256	*See* UCRL–100992			
CONF-891093–		(36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989)			
26	15:22968	*See* UCRL–98747			
CONF-891094–		(International conference on accelerator and large experimental physics control systems; Vancouver (Canada); 30 Oct - 3 nov 1989)			
16	15:22398	*See* SLAC-PUB–5129			
CONF-891103–		(Winter meeting of the American Nuclear Society; San Francisco, CA (USA); 26-30 Nov 1989)			
67	15:22942	*See* UCRL–101262			
CONF-891106–		(31. annual meeting of the Division of Plasma Physics of the American Physical Society; Joint conference of the 6. international conference on plasma physics and on the 6. international congress on plasma waves and plasma instabilities; Anaheim, CA (USA); Lausanne (Switzerland); 13-17 Nov 1989; 27 jun - 3 jul 1)			
10	15:23066	*See* PPPL–2680			
CONF-891111–		(International gas research conference; Tokyo (Japan); 6-9 Nov 1989)			
5	15:21370	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago IL 60616		TI90007592	
CONF-8911128–		(NEANDC specialists' meeting on level densities; Bologna (Italy); 15-17 Nov 1989)			
5	15:22928	*See* UCRL–101772			
CONF-8911164–		(1989 superstrings workshop; Tuscaloosa, AL (USA); 8-11 Nov 1989)			
2	15:22909	*See* DOE/ER/40272–94			
CONF-8911166–		(Total exposure assessment methodology Environmental Protection Agency symposium; Las Vegas, NV (USA); 27-30 Nov 1989)			
2	15:22002	*See* LBL–28321			
CONF-8911168–		(Materials Research Society meeting on diamond, boron nitride, silicon carbide and related wide bandgap semiconductors; Boston, MA (USA); 27 Nov - 2 dec 1989)			
1	15:22137	*See* BNL–43772			
CONF-8911170–		(Host State Technical Coordinating Committee meeting; Gaithersburg, MD (USA); 15-17 Nov 1989)			
1	15:21489	*See* EGG-M–89471			
CONF-8911171–		(U.S. Army CRDEC scientific conference on chemical defense research; Aberdeen Proving Ground, MD (USA); 13-17 Nov 1989)			
1	15:22223	*See* LA-UR–90-485			
CONF-8911173–		(5. annual hazardous materials management conference; Long Beach, CA (USA); 7-9 Nov 1989)			
1	15:21527	*See* UCRL–101967			
2	15:21526	*See* UCRL–101966			

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CONF-8911174–		(European Society for Analytical Cellular Pathology on advances in analytical cellular pathology; Schloss Elmau (Germany, F.R.); 12-17 Nov 1989)			
1	15:22719	*See* UCRL–102862			
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
102	15:22856	*See* LBL–28206			
103	15:22972	*See* LBL–27461			
104	15:22965	*See* LBL–27522			
105	15:21460	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007788	MF-814
106	15:21461	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007789	MF-814
107	15:22168	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008409	MF-114
108	15:22138	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008488	MF-404; MF-410
110	15:22945	*See* BNL–43872			
CONF-891129–		(Scientific basis for nuclear waste management; Boston, MA (USA); 27-30 Nov 1989)			
2	15:21462	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007800	MF-510
CONF-891167–		(Eastern oil shale symposium; Lexington, KY (USA); 15-17 Nov 1989)			
4	15:21430	*See* UCRL–102702			
CONF-891182–		(International conference on plasma physics; New Delhi (India); 22-28 Nov 1989)			
3	15:23056	*See* LA-UR–90-692			
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
21	15:23107	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007807	MF-423
22	15:23141	*See* PNL-SA–16984			
23	15:23142	*See* PNL-SA–16989			
24	15:23144	*See* PNL-SA–16998			
25	15:23143	*See* PNL-SA–16990			
CONF-891205–		(IEEE international electron devices meeting; Washington, DC (USA); 3-6 Dec 1989)			
4	15:22334	*See* UCRL–101479			
CONF-891273–		(4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989)			
2	15:23209	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008745	MF-405
CONF-891276–		(Workshop on high energy astrophysics in the 21st century; Taos, NM (USA); 10-14 Dec 1989)			
5	15:22429	*See* EGG–10617-2051			
CONF-891277–		(Symposium honoring Thomas H. Pigford; Berkeley, CA (USA); 1 Dec 1989)			
1	15:23196	*See* LBL–28101			
CONF-891278–		(Astrophysics meeting; Tuscalosa, AL (USA); 3-7 Dec 1989)			
1	15:22811	*See* LA-UR–90-432			
CONF-891281–		(Scientific and technical information coordinating group meeting; Washington, DC (USA); 10 Dec 1989)			
1	15:23251	*See* EGG–10617-1066			
CONF-900107–		(4. Berkeley international conference on erosion-corrosion-wear of materials at elevated temperatures; Berkeley, CA (USA); 31 Jan - 2 feb 1990)			
2	15:21165	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007806	MF-113
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
12-Rev.1	15:22486	*See* UCRL–99967-Rev.1			
13	15:22324	*See* LA-UR–90-413			
CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990)			
29	15:22422	*See* ANL-HEP-CP–90-2			
31-Rev.1	15:22450	*See* UCRL–100794-Rev.1			

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CONF-900147–		(13. symposium on nuclear physics; Oaxtepec (Mexico); 3-6 Jan 1990)			
2	15:22926	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007481	MF-413
CONF-900153–		(28. AIAA aerospace sciences meeting; Reno, NV (USA); 8-11 Jan 1990)			
	15:21574	*See* N–90-14284			
CONF-900163–		(Accelerator computer code meeting; Los Alamos, NM (USA); 22-25 Jan 1990)			
6	15:23156	*See* UCRL–102907			
CONF-900173–		(Global Modeling of Atmospheric Chemistry (GLOMAC) workshop; Schloss Ringberg (Germany, F.R.); 28 Jan - 2 feb 1990)			
1	15:22495	*See* BNL–43838			
CONF-900174–		(CIT West Coast physics meeting; San Diego, CA (USA); 29 Jan 1990)			
1-Vugraphs	15:22987	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007575	MF-420
CONF-900176–		(ORNL chaos workshop; Oak Ridge, TN (USA); 10-11 Jan 1990)			
1	15:22979	*See* ORNL/TM–11468			
CONF-900178–		(Biomedical optics '90; Los Angeles, CA (USA); 14-19 Jan 1990)			
2	15:22754	*See* LA-UR–90-419			
CONF-900179–		(Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung; Los Alamos, NM (USA); 25-26 Jan 1990)			
1	15:22943	*See* UCRL–102806			
CONF-900206–		(119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990)			
2	15:22139	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007796	MF-201
3	15:22140	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007795	MF-201
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
23	15:21620	*See* SAND–89-2236C			
24	15:21534	*See* WHC-SA–0715			
CONF-900214–		(6. international conference on data engineering; Los Angeles, CA (USA); 5-9 Feb 1990)			
2	15:23253	*See* LBL–27359			
CONF-900224–		(International symposium on radon and radon reduction technology; Atlanta, GA (USA); 19-23 Feb 1990)			
4	15:22748	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007790	
CONF-900229–		(International symposium on borehole geophysics for petroleum, hydrogeology, mining and engineering applications; Tucson, AZ (USA); 1-7 Feb 1990)			
2	15:22794	*See* LBL–28279			
CONF-900254–		(14. symposium on explosives and pyrotechnics; Burlingame, CA (USA); 13-15 Feb 1990)			
2	15:22469	*See* MLM–3628-OP			
CONF-900271–		(NEPCON '90: National Electronic Packaging and Production conference; Anaheim, CA (USA); 26 Feb - 1 mar 1990)			
2	15:22120	*See* LBL–28405			
CONF-900280–		(International workshop on magnetic pulse compression; Lake Tahoe, NV (USA); 12-14 Feb 1990)			
2	15:22402	*See* UCRL–102620			
CONF-900285–		(SPIE astronomical telescopes and instrumentation for the 21st century symposium; Tucson, AZ (USA); 11-17 Feb 1990)			
1	15:22455	*See* UCRL–101574			
CONF-900288–		(2. transport task force workshop; Hilton Head, SC (USA); 19-23 Feb 1990)			
4	15:22988	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007479	MF-421
CONF-900289–		(International workshop on the polarized ion sources and polarized gas jets; Tsukuba-Shi (Japan); 12-17 Feb 1990)			
1	15:22846	*See* BNL–43835			
2	15:22378	*See* BNL–43913			

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3	15:22375	*See* BNL–43877			
CONF-900290–		(1. workshop on neural networks: academic/industrial/NASA/defense; Auburn, AL (USA); 5-6 Feb 1990)			
2	15:23210	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007483	MF-405
CONF-900297–		(1990 American Society for Engineering education conference; Lake Buena Vista, FL (USA); 5-9 Feb 1990)			
1	15:23257	*See* UCRL–102827			
CONF-900299–		(6. annual west coast meeting of the Alternative Natural Philosophy Association; Stanford, CA (USA); 10-11 Feb 1990)			
1	15:22980	*See* SLAC-PUB–5189			
CONF-9003100–		(International workshop on cold neutron sources; Los Alamos, NM (USA); 5-8 Mar 1990)			
1	15:21789	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008399	MF-406
CONF-9003103–		(SHARE '74 conference; Anaheim, CA (USA); 4-9 Mar 1990)			
1	15:22399	*See* SLAC-PUB–5187			
CONF-900311–		(41. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy; New York, NY (USA); 5-9 Mar 1990)			
2	15:21533	*See* WHC-SA–0682			
CONF-900377–		(Energy and the environment in the 21st century; Cambridge, MA (USA); 26-28 Mar 1990)			
2	15:21631	*See* LA-UR–90-698			
CONF-900393–		(International forum on fine ceramics '90; Nagoya (Japan); 12-16 Mar 1990)			
2	15:22141	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008758	MF-332
CONF-900396–		(IRIS Specialty Group meeting on passive sensors and atmospheric physics; Laurel, MD (USA); 13 Mar 1990)			
1	15:22275	*See* SAND–90-0495C			
CONF-900406–		(International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990)			
34	15:21495	*See* LA-UR–90-371			
35	15:21501	*See* LBL–28328			
36	15:21502	*See* LBL–28333			
37	15:21463	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007791	MF-510
38	15:21503	*See* LBL–28358			
39	15:21500	*See* LBL–28316			
40	15:21456	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008405	MF-820
43	15:21504	*See* LBL–28362			
CONF-9004136–		(5. IEEE symposium on electromagnetic launch technology; Destin, FL (USA); 1-5 Apr 1990)			
1	15:22330	*See* SAND–89-2070C			
4	15:22035	*See* SAND–89-2111C			
5	15:22037	*See* SAND–89-2113C			
6	15:22036	*See* SAND–89-2112C			
7	15:22038	*See* SAND–90-0630			
CONF-9004138–		(3. international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990)			
1	15:21734	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007655	MF-505
2	15:22321	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007485	MF-520
CONF-9004139–		(Poland steel conference; Krynica (Poland); 23-26 Apr 1990)			
1	15:22119	*See* LBL–28294			
CONF-9004140–		(Workshop on monitoring equipment environments during nuclear plant operation; Baltimore, MD (USA); 10-11 Apr 1990)			
1	15:22281	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007576	
CONF-9004144–		(Annual ACM south eastern region conference; Atlanta, GA (USA); 13 Apr 1990)			
1	15:22591	NTIS, PC A03/MF A01 - OSTI		DE90008497	MF-405
CONF-9004148–		(USENIX C++ conference; San Francisco, CA (USA); 9-11 Apr 1990)			
1	15:23229	*See* SAND–90-0052C			

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CONF-9004149–		(DOE/ANL training course on the prevention of significant nuclear events; Augusta, GA (USA); Apr 1990)			
1	15:21547	*See* WSRC-RP–89-1298			
CONF-900418–		(International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990)			
6	15:21732	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007798	MF-530
7	15:21718	NTIS, PC A03/MF A01; OSTI; INIS		DE90008742	MF-413
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
2	15:22158	*See* UCRL–102017			
CONF-900426–		(7. symposium on enhanced oil recovery: global prospects and perspectives; Tulsa, OK (USA); 22-25 Apr 1990)			
1	15:21287	*See* LA-UR–90-564			
CONF-900507–		(22. offshore technology conference and exhibition (OTC-22); Houston, TX (USA); 7-10 May 1990)			
1	15:21205	*See* SAND–89-2297C			
CONF-900508–		(FLOWERS '90: Florence world energy research symposium; Florence (Italy); 28 May - 1 jun 1990)			
1	15:22257	*See* LA-UR–90-590			
CONF-9005105–		(10. IEEE symposium on mass storage systems; Monterey, CA (USA); 7-10 May 1990)			
1	15:23218	*See* LA-UR–90-32			
2	15:23234	*See* UCRL–102664			
3	15:23235	*See* UCRL–102665			
4	15:23233	*See* UCRL–102663			
CONF-9005106–		(13. annual conference of the Computer Security Group; Augusta, GA (USA); 8-10 May 1990)			
1	15:23200	*See* SAND–89-2700C			
CONF-9005107–		(ANTEC '90: Society of Plastics Engineers meeting; Dallas, TX (USA); 7-11 May 1990)			
1	15:22187	*See* SAND–90-0077C			
CONF-9005108–		(Symposium on structured continua; Sherbrooke (Canada); 22-25 May 1990)			
1	15:22875	*See* SAND–89-3040C			
CONF-9005115–		(4. U.S. conference on earthquake engineering; Palm Springs, CA (USA); 20-24 May 1990)			
1	15:22792	*See* EGG-M–89247			
CONF-9005116–		(1990 international symposium on circuits and systems; New Orleans, LA (USA); 1-3 May 1990)			
1	15:22332	*See* SAND–90-0231C			
CONF-9005118–		(U.S. Army symposium on gun dynamics; Tamiment, PA (USA); 14-17 May 1990)			
1	15:22465	*See* LA-UR–90-650			
CONF-9005122–		(1990 conference on the application of 3-D hydrocodes to armor/anti-armor problems; Aberdeen Proving Ground, MD (USA); 7-11 May 1990)			
1	15:22468	*See* UCRL–102995			
CONF-9005133–		(International conference on composite interfaces; Cleveland, OH (USA); 21-24 May 1990)			
1	15:22167	*See* BNL–43876			
CONF-900530–		(Conference on lasers and electro-optics; Anaheim, CA (USA); 21-25 May 1990)			
1	15:23132	*See* LA-UR–89-4110			
2	15:22331	*See* SAND–89-3025C			
3	15:22192	*See* UCRL–102644			
4	15:22335	*See* UCRL–102645			
5	15:23154	*See* UCRL–102536			
6	15:23155	*See* UCRL–102537			
7	15:22100	*See* BNL–43791			
8	15:22456	*See* UCRL–102525			

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CONF-900532–		(37. international technical communications conference; Santa Clara, CA (USA); 20-23 May 1990)			
2	15:23217	*See* LA-UR–89-2722			
3	15:23219	*See* LA-UR–90-613			
4	15:23247	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007802	MF-400
CONF-900553–		(Western regional symposium on mining and mineral processing wastes; Berkeley, CA (USA); 30 May - 1 jun 1990)			
1	15:21496	*See* LA-UR–90-701			
CONF-900559–		(IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990)			
1	15:22262	*See* SAND–89-2414C			
2	15:22267	*See* SAND–89-2522C			
3	15:22266	*See* SAND–89-2511C			
4	15:22268	*See* SAND–89-2527C			
5	15:22247	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001731	MF-406
6	15:22265	*See* SAND–89-2510C			
7	15:22248	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001952	MF-406
8	15:22249	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001953	MF-406
9	15:22260	*See* SAND–89-2044C			
10	15:22264	*See* SAND–89-2506C			
11	15:22263	*See* SAND–89-2494C			
12	15:22250	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008753	
CONF-900562–		(Meeting of the Electrochemical Society; Montreal (Canada); 6-11 May 1990)			
1	15:22185	*See* SAND–89-1930C			
2	15:21120	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004936	MF-114
CONF-900564–		(Association for Computing Machines (ACM) sigmetrics '90 conference; Boulder, CO (USA); 22-25 May 1990)			
1	15:23231	*See* UCRL–101868			
CONF-900566–		(1990 American Society for Quality Control (ASQC) congress; San Francisco, CA (USA); 14 May 1990)			
1	15:23198	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90003687	MF-400
2	15:23201	*See* UCRL–101159			
CONF-900568–		(IEEE AP-S international symposium and URSI science meeting; Dallas, TX (USA); 7-11 May 1990)			
1	15:22795	*See* SAND–89-2764C			
CONF-900580–		(1990 Digital Equipment Corporation User's Society meeting; New Orleans, LA (USA); 7-11 May 1990)			
1	15:21444	*See* WSRC-RP–89-1100			
2	15:23147	*See* SAND–90-0746C			
CONF-900587–		(10. TIMS international DSS conference on information technology for executives and managers; Boston, MA (USA); 21-23 May 1990)			
1	15:21457	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005277	MF-405
CONF-900588–		(45. annual meeting of the Society of Tribologists and Lubrication Engineers; Denver, CO (USA); 7-10 May 1990)			
1	15:22169	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005665	MF-373
2	15:22170	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005632	MF-373
CONF-900597–		(International workshop on formal methods in software development; Napa, CA (USA); 9-11 May 1990)			
1	15:21733	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005633	MF-405
CONF-900598–		(4. international symposium on silicon-on-insulators technology and device; Montreal (Canada); 6-11 May 1990)			
1	15:22186	*See* SAND–89-2696C			
CONF-900599–		(36. ISA international instrumentation symposium; Denver, CO (USA); 6-10 May 1990)			
1	15:22481	*See* SAND–89-2293C			
2	15:22480	*See* SAND–89-2262C			
3	15:21652	*See* SERI/TP–257-3663			
CONTRIBK– 4930	15:22198	*See* AD-A–214573/8/XAB			

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CRC–					
566	15:21306	*See* AD-A–214845/0/XAB			
CRIE-W–					
88023	15:21861	NTIS (US Sales Only), PC A03/MF A01		DE90753094	
88024	15:21862	NTIS (US Sales Only), PC A03/MF A01		DE90753095	
88026	15:21166	NTIS (US Sales Only), PC A03/MF A01		DE90753096	
88029	15:21852	NTIS (US Sales Only), PC A03/MF A01		DE90753098	
88036	15:21121	NTIS (US Sales Only), PC A03/MF A01		DE90753099	
88039	15:21863	NTIS (US Sales Only), PC A03/MF A01		DE90753100	
CRIEPI–					
EY-89001	15:21178	Central Research Institute of Electric Power Industry, Tokyo, Japan			
CRN-CPR–					
84-5	15:22428	NTIS (US Sales Only), PC A02/MF A01		DE90756441	
87-03	15:22219	NTIS (US Sales Only), PC A08/MF A01		DE90756401	
88-08	15:22220	NTIS (US Sales Only), PC A03/MF A01		DE90756412	
CRN-PN–					
8803	15:22933	NTIS (US Sales Only), PC A03/MF A01		DE90756410	
CRN-VIV–					
55/2	15:22358	NTIS (US Sales Only), PC A02/MF A01		DE90756414	
CSR–					
90-01181	15:22294	PC Canada Oil and Gas Lands Administration, 355 River Road, 15th FLoor, Tower B, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
C225F	15:21608	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CSSA-ASTRO–					
89-11	15:22821	*See* N–90-14178			
CT–					
171-16A	15:22515	*See* PB–90-131343/XAB			
171-17A	15:22514	*See* PB–90-131335/XAB			
CTN–					
89-007	15:23255	*See* UCID–21679-Rev.1			
DCN–					
89-218-066-05	15:21138	*See* PB–90-131541/XAB			
DESY–					
88-192	15:22891	*See* LAL–88-61			
DHHS/PUB/FDA–					
89-8276	15:22732	*See* PB–90-131624/XAB			
DIDSG-P–					
(88)388	15:21717	*See* CEGB-RD-B–6210/R89			
DLR-FB–					
89-61	15:22497	NTIS (US Sales Only), PC A06/MF A01; OSIT; INIS		DE90759539	
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89.001	15:22204	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619236	
89.012	15:21477	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90620401	
89.036	15:21478	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620402	
89.063	15:21479	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620390	
89.066	15:22599	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619474	
DOE/BC/10302–					
46	15:21285	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000228	PC-122
DOE/BC/10846–					
15	15:21286	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000226	PC-122
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1	15:21318	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000221	PC-122

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1281	15:21934	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008454	MF-900
1301	15:21935	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008455	MF-900
1323	15:21963	NTIS, PC A04/MF A01 - OSTI		DE90008462	MF-603
1326	15:21964	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008450	MF-920
1327	15:21602	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008446	MF-902
1329	15:21936	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008445	MF-900
DOE/BP/01830–					
4	15:21603	NTIS, PC A09/MF A01 - OSTI		DE90008448	MF-902
DOE/BP/14903–					
2	15:21604	NTIS, PC A03/MF A01 - OSTI		DE90008449	MF-902
DOE/BP/23821–					
2	15:21965	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008456	MF-920
DOE/BP/34625–					
1	15:21966	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008475	MF-350
2	15:21967	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008453	MF-350
DOE/BP/35389–					
T1	15:21856	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008477	MF-221
DOE/BP/35677–					
1	15:22043	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008476	MF-314
DOE/BP/39461–					
5	15:21605	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008452	MF-602
DOE/CE–					
0281	15:21886	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007645	MF-220
DOE/CE/15434–					
T1	15:21968	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008469	MF-350
DOE/CH/10093–					
58	15:21614	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009473	MF-270
60	15:21610	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009475	MF-234
62	15:21625	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009477	MF-231; MF-232
72	15:21937	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009487	MF-201
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0077P	15:21549	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008039	PC-731
1302	15:21606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008447	MF-900
DOE/EA–					
0407	15:22767	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008109	PC-133
DOE/EH–					
0096	15:21464	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008125	MF-630
0125-Vol.2	15:22491	NTIS, PC A23/MF A01 - OSTI		DE90008116	MF-630
0125-Vol.3	15:22492	NTIS, PC A19/MF A01 - OSTI		DE90008117	MF-630
0128	15:22751	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006342	MF-607
DOE/EH/79072–					
T3	15:22251	NTIS, PC A05/MF A01 - OSTI		DE90007558	MF-607
DOE/EH/79081–					
T1	15:21448	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007566	MF-610
DOE/EIA–					
0109(89/12)	15:21319	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90008379	MF-950
0130(89/12)	15:21365	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007868	MF-950
0173(89)	15:21923	NTIS, PC A04/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007494	MF-950
0380(89/12)	15:21320	NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90008528	MF-950
0437(88)	15:21938	NTIS, PC A99/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90008781	MF-950
0464(88)	15:22032	NTIS, PC A10/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007867	MF-950
0523(89/3Q)	15:21321	NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007493	MF-950
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0132-F	15:21539	NTIS, PC A17/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008332	MF-902
DOE/ER–					
0313/7	15:23108	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008083	PC-423; PC-424
0439	15:22768	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008118	MF-407
0441	15:22498	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008108	PC-402
0442	15:22499	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006349	PC-402
DOE/ER/10495–					
3	15:22929	NTIS, PC A02/MF A01; OSTI; INIS		DE90007668	MF-413
DOE/ER/10569–					
T5	15:22366	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008328	MF-414
DOE/ER/13053–					
5	15:22710	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007661	MF-408
8	15:21581	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007549	MF-408

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DOE/ER/13086–T1	15:22711	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008433	MF-408
DOE/ER/13182–T1	15:22787	Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301			ND-403
T2	15:22788	Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Bounder, CO 80301			ND-403
DOE/ER/13368–6	15:22712	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007660	MF-408
DOE/ER/13400–9	15:22240	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008412	MF-401
DOE/ER/13441–5	15:22958	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007555	MF-404
DOE/ER/13496–4	15:22713	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007667	MF-408
DOE/ER/13570–4	15:22221	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007523	MF-401; MF-404
DOE/ER/13574–5	15:22714	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007663	MF-408
DOE/ER/13592–T2	15:22229	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008421	MF-401
DOE/ER/13674–3	15:22959	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008414	MF-401
DOE/ER/13862–T1	15:21582	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008485	MF-408
DOE/ER/13937–2	15:22230	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008273	MF-401
DOE/ER/14018–1	15:22457	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007693	MF-401
DOE/ER/25015–29	15:23211	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008429	MF-405
DOE/ER/25029–2	15:23212	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008292	MF-405
DOE/ER/25063–2	15:23250	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008440	MF-405; MF-406
DOE/ER/35012–T3	15:21790	NTIS, PC A07/MF A01; OSTI; INIS		DE90007269	MF-400
DOE/ER/40173–5	15:22899	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007752	MF-414
DOE/ER/40215–T10	15:22900	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007671	MF-414
DOE/ER/40264–4	15:22934	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008427	MF-413
DOE/ER/40272–94	15:22909	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007694	MF-414
DOE/ER/40366–2	15:22879	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007751	MF-414
DOE/ER/40368–3	15:22882	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008272	MF-414
DOE/ER/40437–2	15:22915	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007672	MF-414
DOE/ER/45061–6	15:22105	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008430	MF-404
DOE/ER/45125–T2	15:22960	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008330	MF-411
DOE/ER/45167–T1	15:22142	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008329	MF-404
DOE/ER/45249–T1	15:22143	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007880	MF-404
DOE/ER/45259–8	15:22171	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007669	MF-401
DOE/ER/45303–2	15:22144	NTIS, PC A03/MF A01 - OSTI		DE90008424	MF-404
DOE/ER/45310–20	15:22106	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008428	MF-404
DOE/ER/45362–2	15:22172	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008249	MF-404

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/45379–					
1	15:22107	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007809	MF-404
DOE/ER/45396–					
1	15:22145	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008253	MF-406
DOE/ER/45405–					
1	15:22961	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008250	MF-410
DOE/ER/52111–					
T6	15:23109	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008281	MF-420
DOE/ER/52158–					
1	15:23110	NTIS, PC A03/MF A01 - OSTI		DE90008252	MF-422
DOE/ER/60161–					
T1	15:22592	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007434	MF-402
T2	15:22593	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007438	MF-403
T3	15:22594	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007437	MF-403
T4	15:22595	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007436	MF-403
T5	15:22596	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007435	MF-403
DOE/ER/60312–					
3	15:22500	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007184	MF-402
DOE/ER/60348–					
12	15:22789	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008439	MF-402
DOE/ER/60445–					
4	15:22203	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008373	MF-401
DOE/ER/60460–					
4	15:22724	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008420	MF-408
DOE/ER/60470–					
1	15:22597	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006721	MF-402
DOE/ER/60530–					
3	15:21576	NTIS, PC A02/MF A01 - OSTI		DE90007417	MF-407
DOE/ER/60577–					
2	15:21540	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007556	MF-402
DOE/ER/60649–					
T2	15:22715	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008314	MF-408
DOE/ER/60707–					
2	15:22952	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008413	MF-408
DOE/ER/60858–					
T1	15:22381	NTIS, PC A02/MF A01 - OSTI		DE90008444	MF-406
DOE/ER/60867–					
1	15:22953	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007366	MF-407
DOE/ER/60883–					
1	15:22501	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007565	MF-402
DOE/ER/80592–					
T2	15:22290	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007749	MF-406
DOE/ET/15601–					
32	15:21950	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005964	MF-112
35	15:21951	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004969	MF-112
36	15:21952	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007171	MF-112
DOE/ET/20279–					
1	15:21615	NTIS, PC A05/MF A01 - OSTI		DE90008432	MF-276
T15	15:21616	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008431	MF-276
DOE/ET/51013–					
276	15:22989	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007640	MF-426
278	15:22990	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007638	MF-427
279	15:22991	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007639	MF-426
DOE/FE–					
0165	15:21932	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008030	PC-126
DOE/HWP–					
89	15:21465	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006750	MF-721
DOE/ID–					
10238	15:21791	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007065	MF-520
22085	15:22543	NTIS, PC A05/MF A01; OSTI; INIS; USGS-OFR, U.S.G.S. Open File Service, Box 25425-Denver Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE90006967	MF-502
DOE/ID/12371–					
T1	15:21466	NTIS, PC A02/MF A01; OSTI; INIS		DE90007263	MF-512
DOE/ID/12735–					
T6	15:21953	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008278	MF-112
DOE/ID/12847–					
T1	15:22108	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008142	MF-312
DOE/IE/10574–					
T1	15:21202	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008470	MF-903; MF-930

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DOE/LLW–					
13Tg-Rev.2-Vol.1	15:21467	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008008	PC-721; PC-512
13Tg-Rev.2-Vol.2	15:21468	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008009	PC-721; PC-512
DOE/MC/21181–					
1950-Vol.12	15:21353	NTIS, PC A13/MF A01 - OSTI		DE90000431	MF-132
1950-Vol.14	15:21354	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000451	MF-132
DOE/MC/23257–					
2801	15:21167	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000463	MF-104; MF-111
DOE/MC/23291–					
2780	15:21122	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000432	MF-109
DOE/MC/24222–					
2790	15:21956	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000443	MF-110
DOE/METC–					
89/6107-Vol.1	15:21123	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011706	MF-106; MF-109
89/6107-Vol.2	15:21124	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011707	MF-106; MF-109
DOE/NASA–					
0282-1	15:22080	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008025	PC-336
DOE/NASA/50162–					
3	15:22033	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006338	PC-332
DOE/NP–					
0002	15:21785	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007644	MF-520
0003	15:22544	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007646	MF-520
DOE/NV–					
337	15:22475	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008370	MF-700
DOE/OR/00033–					
T431	15:21969	NTIS, PC A06/MF A01 - OSTI		DE90007742	MF-407
T432	15:22598	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007697	MF-408
T433	15:21570	University of Michigan, Ann Arbor, MI 48109			MF-414
T435	15:21469	Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139			ND-510
T436	15:21470	Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139			ND-510
DOE/OR/21389–					
24	15:21589	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007666	MF-247
DOE/OR/21390–					
26	15:21575	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007665	MF-247
DOE/OR/21548–					
063-Rev.1	15:21471	NTIS, PC A11/MF A01; OSTI; INIS		DE90007843	MF-511
066	15:21472	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007863	MF-511
104	15:21473	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008115	MF-511
105	15:21474	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007866	MF-511
DOE/PC/80512–					
T16	15:21157	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006784	PC-107
DOE/PC/88810–					
4	15:21303	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007423	MF-108
DOE/PC/88867–					
T5	15:21660	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006171	PC-105
DOE/PC/88878–					
T5	15:21147	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007229	MF-113
DOE/PC/88918–					
5	15:21168	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008279	MF-105
DOE/PC/88919–					
T3	15:21125	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007228	MF-108
DOE/PC/88941–					
T5	15:21148	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007427	MF-102
DOE/PC/88951–					
3	15:21149	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007425	MF-114
DOE/PC/89780–					
T2	15:21150	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008276	MF-113
DOE/PC/89877–					
1	15:21126	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008280	MF-108
DOE/PC/90528–					
T7	15:21127	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004178	PC-108
DOE/PC/90956–					
T9	15:21164	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008498	MF-115

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/PE/79027–					
T1	15:21939	NTIS, PC A03/MF A01 - OSTI		DE90008471	MF-900
DOE/RL–					
89-23	15:21475	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007812	MF-721
90-12	15:21476	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008295	MF-721
DOE/RL/10355–					
T1	15:22840	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008472	MF-506
DOE/RW–					
0263	15:21480	OSTI; INIS		TI90008132	MF-800
DOE/SF/16306–					
20	15:21626	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007698	MF-231
DP–					
1770	15:21449	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008124	PC-704
1776	15:21441	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008127	PC-701
1777	15:21481	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008123	PC-721
DPDG–					
89/04	15:22895	*See* RAL–89-106			
DPST–					
73-225	15:21792	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007718	MF-706
DRES–					
1275	15:22489	*See* AD-A–214763/5/XAB			
DU/IRES–					
89-05633	15:21590	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
E–					
4307	15:22122	*See* N–90-13819			
4674	15:21857	*See* N–90-13596			
4733	15:22124	*See* N–90-14642			
4848	15:22272	*See* N–90-13387			
5007	15:22258	*See* N–90-13590			
5057	15:22123	*See* N–90-14641			
5060	15:22152	*See* N–90-13666			
5074	15:22182	*See* N–90-14287			
5083	15:21712	*See* N–90-15030			
5112	15:22463	*See* N–90-13761			
5123	15:22273	*See* N–90-14844			
5131	15:22181	*See* N–90-14108			
5160	15:22151	*See* N–90-13636			
5167	15:22153	*See* N–90-14362			
5188	15:22154	*See* N–90-14368			
5246	15:21574	*See* N–90-14284			
EC–					
90-00642	15:21592	PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ECN–					
216	15:22946	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706032	
219	15:22173	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90706033	
221	15:22458	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706034	
ECRC/M–					
2344	15:22044	Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.			
2433	15:21867	Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.			
ECRC/R–					
2354	15:21864	Available from Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.			
2393	15:21868	Available from: Electricity Council Research Centre, Capenhurst, Chester, CH1 6ES, UK.			

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ECTB–					
171-15A	15:22516	*See* PB–90-131350/XAB			
EE-TR–					
7910	15:23246	*See* AD-A–214592/8/XAB			
EEG–					
4	15:21482	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007633	MF-721
8	15:21483	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007632	MF-721
9	15:21484	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007631	MF-721
22	15:21485	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007634	MF-702
24	15:21486	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007635	MF-721
25	15:21487	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007370	MF-721
EGG–					
10617-1066	15:23251	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008246	MF-700
10617-2051	15:22429	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008751	MF-706
10617-6062	15:22790	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008247	MF-703; MF-706
10617-6066	15:22791	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008248	MF-703; MF-706
2555-Vol.4	15:21842	*See* NUREG/CR–5273-Vol.4			
2566	15:21846	*See* NUREG/CR–5376			
2577-Vol.2	15:21841	*See* NUREG/CR–5229-Vol.2			
EGG-EAST–					
8829	15:21793	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007414	MF-520
EGG-M–					
89247	15:22792	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006983	MF-502
89442	15:21488	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007015	MF-721
89471	15:21489	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007017	MF-600
EJF–					
89-05944	15:22174	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
EMR–					
104	15:21327	PC Canada. Environment Canada Water Quality Branch, 1st Floor, Motherwell Bldg.,, 1901 Victoria Avenue, Regina, SK, CAN S4P 3R4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
89-06352	15:21415	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
89-06353	15:21416	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
M1-5/1987	15:21902	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
EMR/CR–					
89-06211	15:21417	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
EMR/EMAS–					
90-00944	15:21888	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-01054	15:21924	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
ENEA-RT-VEL–					
85-2	15:21708	NTIS (US Sales Only), PC A03/MF A01		DE89761985	
EPA–					
450/4-89/001	15:22511	*See* PB–90-130352/XAB			
520/5-88/057	15:22521	*See* PB–90-131491/XAB			
520/5-88/058	15:22522	*See* PB–90-131509/XAB			
560/1-89/001	15:21898	*See* PB–90-133372/XAB			
600/D-89/205	15:22526	*See* PB–90-132689/XAB			
600/D-89/208	15:22052	*See* PB–90-132812/XAB			
EPRI-CU–					
6562	15:22045	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6604	15:21940	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6632	15:21942	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6685	15:22081	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6686	15:21970	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6690-Vol.2	15:21971	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6702-Vol.1	15:22046	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6739	15:21972	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6746	15:21949	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-GS–					
6620-Vol.2	15:21876	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6673-Vol.2	15:21655	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6673-Vol.3	15:21656	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6673-Vol.4	15:21657	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6688	15:21877	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6711	15:21661	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6712	15:21607	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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6718	15:21879	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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6751	15:21158	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6776	15:21658	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-NP–					
6147-Vol.3	15:21794	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6477	15:22109	Research Reports Center, Box 50490, Palo Alto, CA 94303			

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EPRI-NP–					
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6647	15:21797	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6668-Vol.2	15:21741	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6668-Vol.3	15:21742	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6668-Vol.4	15:21798	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6697	15:22252	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6701	15:21689	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6708	15:21799	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6713	15:21800	Research Reports Center, Box 50490, Palo Alto, CA 94303			
ERCB–					
89-40	15:21903	PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ERCI-R–					
88-93	15:22092	NTIS (US Sales Only), PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007553	MF-900
ESL–					
8905772	15:21322	PC Canada Dept. of Fisheries and Oceans, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
ETN–					
89-95858	15:22815	*See* N–90-14156			
EUR–					
12292-EN	15:21163	Commission of the European Communities, Luxembourg			
EUR-CEA-FC–					
1345	15:22992	NTIS (US Sales Only), PC A03/MF A01			
1355	15:22993	NTIS (US Sales Only), PC A03/MF A01			
1360	15:22994	NTIS (US Sales Only), PC A03/MF A01			
1361	15:22430	NTIS (US Sales Only), PC A03/MF A01			
1365	15:22995	NTIS (US Sales Only), PC A03/MF A01			
EUR-FC–					
1358	15:21735	NTIS (US Sales Only), PC A03/MF A01			
FCPRL–					
8903	15:23109	*See* DOE/ER/52111–T6			
FE–					
15601-36	15:21952	*See* DOE/ET/15601–36			
FERMILAB-CONF–					
89/254-A	15:22818	*See* N–90-14167			
FERMILAB-PUB–					
89/193-A	15:22813	*See* N–90-14076			
89/208-A	15:22812	*See* N–90-13297			
89/252-A	15:22819	*See* N–90-14168			
FJSRL-JR–					
89-0014	15:22217	*See* AD-A–214891/4/XAB			
FLPU–					
87-6	15:21478	*See* DOE-RW–89.036			
FMPC–					
2173	15:21541	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007649	MF-707
FMPC/Sub–					
018	15:21542	NTIS, PC A21/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008771	MF-702
FNAL/C–					
89/265-T	15:22901	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008778	MF-414

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90/39	15:22883	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008779	MF-414
FRCEA-TH–					
169	15:22996	NTIS (US Sales Only), PC A09/MF A01		DE90756433	
FRNC-R–					
303	15:22904	NTIS (US Sales Only), PC A05/MF A01		DE90756359	
FRNC-TH–					
3348	15:22997	NTIS (US Sales Only), PC A06/MF A01		DE90756363	
3485	15:21726	NTIS (US Sales Only), PC A14/MF A01		DE90756432	
FSC–					
8903-86	15:21132	NTIS (US Sales Only), PC A03/MF A01		DE90752836	
FSRN-NC–					
350	15:21578	*See* PB–90-131616/XAB			
FTC–					
2312C-1	15:22283	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
FhG-IWM-W–					
1/89	15:22110	Available from Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.)			
FhG-IzfP–					
880335-TW	15:22282	NTIS (US Sales Only), PC A05/MF A01		DE90759068	
GAI–					
89-06232	15:22111	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
GANIL-P–					
87-27	15:22935	NTIS (US Sales Only), PC A04/MF A01		DE90756358	
GAO/NSLAD–					
89-35	15:21917	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
GAO/RCED–					
89-2	15:21918	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
89-104	15:21933	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
89-21	15:21919	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
89-41	15:21920	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
89-66	15:21490	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
GEN-TBMSG-P–					
(88)6479/A/1	15:22101	*See* CEGB-RD-B–6032/R88			
GEPP-TIS–					
1168	15:22322	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008044	MF-706
GKSS–					
89/E/22	15:22112	Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)			
89/E/25	15:22600	Special print from Adv. Space Res. (1989) v. 9(1) p. 191-200			
89/E/26	15:22601	Special print from Vom Wasser, VCH Verlagsges. (1989) v. 72 p. 65-81			
89/E/28	15:22113	Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)			
89/E/29	15:22114	Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)			

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GKSS–					
89/E/31	15:22115	Special print from: Salama, M.M.; Bangaru, N.V.; Denys, R.; Rhee, H.C.; Toyoda, M. (eds.): Eighth international conference on offshore mechanics and Arctic engineering. Vol. 3. American Society of Mechanical Engineers, book no. I0285C - 1989, p. 623-631			
GKYA–					
89-06355	15:21973	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
GL-TR–					
89-0240	15:22836	*See* AD-A–212186/1/XAB			
GRI–					
88/0042.1	15:21369	*See* PB–90-132515/XAB			
90008274	15:21925	OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631		TI90008274	
GRSJ–					
8902	15:21628	NTIS (US Sales Only), PC A06/MF A01		DE90752965	
GSF-BPT–					
1/89	15:22502	NTIS (US Sales Only), PC A14/MF A01		DE90759067	
GSI–					
89-18	15:22231	NTIS (US Sales Only), PC A07/MF A01		DE90759071	
89-31	15:22936	Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
89-86(prepr.)	15:22977	Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
90-01(prepr.)	15:22431	Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
90-02(prepr.)	15:22432	Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
GSJ–					
8902-270	15:21632	NTIS (US Sales Only), PC A21/MF A01		DE90753026	
8903	15:21630	NTIS (US Sales Only), PC A13/MF A01		DE90753032	
GU/G–					
EN57-27/1989-01	15:22503	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
HAZ–					
CE02854	15:22781	Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN			
HEDL-TC–					
1933	15:21775	NTIS, PC A04/MF A01 - OSTI		DE90007175	MF-534
HIFAN–					
442	15:23133	*See* LBL–28264			
HME–					
90-01164	15:21974	PC Innovative Housing Grants Program, Research and Development Section / Housing Division, 16th Floor, Citycentre, 10155 - 102 Street, Edmonton, AB, CAN T5J 4L4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
IAE–					
2053/E-6/R/A	15:21776	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620256	
2060/ORiPI/I/B	15:22232	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619275	
2061/E-1/D/A	15:21801	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619675	
2062/E-3/PP/B	15:21954	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619016	
IAEA-R–					
4390-F	15:22602	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617511	
5012-F	15:22433	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617896	

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5462-F	15:22735	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617634	
IAEA-TECDOC–					
524	15:21802	NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS		DE90620170	
536	15:22998	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90618585	
IAND–					
QS-8439-000-EF-A1	15:21328	PC Indian and Northern Affairs Canada. Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
ICOMP–					
89-27	15:22273	*See* N–90-14844			
IEA-HPC-WR–					
2	15:21975	Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.)			
IFVE-OEF–					
88-179	15:22434	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620305	
88-215	15:22435	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620306	
IFVE-OKU–					
88-207	15:22382	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620105	
IFVE-OLU–					
88-214	15:22367	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620098	
IFVE-ONF–					
88-211	15:22436	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620307	
88-216	15:22437	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620308	
88-217	15:22438	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620309	
IFVE-OP–					
88-187	15:22383	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620110	
IFVE-ORI-ONF–					
88-220	15:22384	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620111	
IFVE-ORI-OP-ONF–					
88-206	15:22385	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620106	
IFVE-OUNK–					
88-218	15:22386	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620107	
89-1	15:22387	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620112	
89-23	15:22388	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620108	
89-24	15:22389	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620109	
IGT–					
90007522	15:21161	Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616 $30.00			
ILWRP–					
88-P1-13	15:21477	*See* DOE-RW–89.012			
INA/NO–					
QS-8435-000-EF-A1	15:21329	PC Indian and Northern Affairs Canada. Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			

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INDAL–					
89-05736	15:21646	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
89-05741	15:21647	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
89-05744	15:21648	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
INDC(JPN)–					
128/L	15:22918	*See* JAERI-M–89-129			
133/L	15:22940	*See* JAERI-M–90-006			
134/L	15:22925	*See* JAERI-M–90-012			
INIS-SU–					
154	15:22368	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620099	
155	15:22809	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618944	
156	15:22810	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618870	
157/A	15:23019	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618767	
158/A	15:22390	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620113	
INIS-mf–					
11470	15:22459	NTIS (US Sales Only), PC A07/MF A01 - OSTI		DE90706035	
11522	15:22851	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706036	
11545	15:22922	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706037	
11546	15:22460	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90706038	
11547	15:22852	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90706039	
11548	15:22853	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706040	
11549	15:23018	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90706041	
11550	15:23113	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90706042	
11551	15:22752	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90706043	
11552	15:22439	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90706044	
11553	15:22923	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90706045	
11554	15:22176	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90706046	
11555	15:22461	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706047	
INS–					
777	15:22391	NTIS (US Sales Only), PC A03/MF A01		DE90759899	
INS-T–					
490	15:22392	NTIS (US Sales Only), PC A03/MF A01		DE90759846	
IPNO-T–					
86-06	15:22393	NTIS (US Sales Only), PC A07/MF A01		DE90756355	
88-01	15:22962	NTIS (US Sales Only), PC A08/MF A01		DE90756356	
89-07	15:22884	NTIS (US Sales Only), PC A05/MF A01		DE90756357	

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IPNO-TH–					
87-52	15:22937	NTIS (US Sales Only), PC A02/MF A01		DE90756442	
87-90	15:22916	NTIS (US Sales Only), PC A06/MF A01		DE90756438	
88-34	15:22910	NTIS (US Sales Only), PC A03/MF A01		DE90756353	
IPP–					
1/251	15:23020	NTIS (US Sales Only), PC A03/MF A01		DE90759507	
2/299	15:23021	NTIS (US Sales Only), PC A03/MF A01		DE90759699	
2/302	15:23022	NTIS (US Sales Only), PC A10/MF A01		DE90759669	
4/237	15:23128	Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)			
4/238	15:23129	NTIS (US Sales Only), PC A04/MF A01		DE90759698	
4/240	15:23038	NTIS (US Sales Only), PC A03/MF A01		DE90759508	
5/29	15:23039	NTIS (US Sales Only), PC A03/MF A01		DE90759504	
5/30	15:23040	NTIS (US Sales Only), PC A03/MF A01		DE90759505	
5/31	15:23041	NTIS (US Sales Only), PC A03/MF A01		DE90759506	
6/285	15:23042	NTIS (US Sales Only), PC A02/MF A01		DE90759509	
6/286	15:23043	NTIS (US Sales Only), PC A02/MF A01		DE90759510	
III/143	15:23044	Available from Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)			
IR–					
87-037	15:23045	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706048	
87-049	15:23046	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706049	
87-058	15:23047	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706050	
IRTA–					
90-00381	15:21587	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ISIS–					
10037U/89-02C	15:23206	*See* AD-A–214810/4/XAB			
ISN–					
87-90	15:22938	NTIS (US Sales Only), PC A05/MF A01		DE90756445	
88-05	15:22924	NTIS (US Sales Only), PC A03/MF A01		DE90756409	
8810	15:22939	NTIS (US Sales Only), PC A03/MF A01		DE90756454	
8820	15:22917	NTIS (US Sales Only), PC A04/MF A01		DE90756408	
89-31	15:22440	NTIS (US Sales Only), PC A07/MF A01		DE90756354	
IVO-A–					
01/89	15:21491	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620391	
IVO-B–					
01/89	15:21154	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619463	
IYaF–					
88-111	15:22323	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620385	
88-30	15:22441	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620311	
89-50	15:22394	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620104	
JA–					
6201	15:22316	*See* AD-A–214649/6/XAB			
JAERI-M–					
89-126	15:23048	NTIS (US Sales Only), PC A17/MF A01		DE90759921	
89-129	15:22918	NTIS (US Sales Only), PC A06/MF A01		DE90759875	
89-137	15:22253	NTIS (US Sales Only), PC A06/MF A01		DE90759877	
89-140	15:22254	NTIS (US Sales Only), PC A03/MF A01		DE90759878	
89-141	15:21709	NTIS (US Sales Only), PC A05/MF A01		DE90759879	
89-144	15:22545	NTIS (US Sales Only), PC A03/MF A01		DE90759881	
89-145	15:23213	NTIS (US Sales Only), PC A05/MF A01		DE90759882	
89-151	15:22854	NTIS (US Sales Only), PC A04/MF A01		DE90759905	
89-152	15:21452	NTIS (US Sales Only), PC A03/MF A01		DE90759883	
89-153	15:23214	NTIS (US Sales Only), PC A03/MF A01		DE90759884	
89-155	15:22504	NTIS (US Sales Only), PC A03/MF A01		DE90759885	
89-156	15:21492	NTIS (US Sales Only), PC A04/MF A01		DE90759922	
89-157	15:23049	NTIS (US Sales Only), PC A04/MF A01		DE90759903	

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89-158	15:21710	NTIS (US Sales Only), PC A03/MF A01		DE90759887	
89-159	15:21711	NTIS (US Sales Only), PC A04/MF A01		DE90759886	
89-161	15:21777	NTIS (US Sales Only), PC A05/MF A01		DE90759888	
89-162	15:21778	NTIS (US Sales Only), PC A05/MF A01		DE90759923	
89-163	15:21442	NTIS (US Sales Only), PC A03/MF A01		DE90759900	
89-164	15:23050	NTIS (US Sales Only), PC A03/MF A01		DE90759889	
89-166	15:23130	NTIS (US Sales Only), PC A05/MF A01		DE90759890	
89-168	15:21453	NTIS (US Sales Only), PC A03/MF A01		DE90759906	
89-169	15:23051	NTIS (US Sales Only), PC A03/MF A01		DE90759892	
89-170	15:22255	NTIS (US Sales Only), PC A03/MF A01		DE90759893	
89-171	15:21550	NTIS (US Sales Only), PC A08/MF A01		DE90759894	
89-172	15:21454	NTIS (US Sales Only), PC A05/MF A01		DE90759924	
89-173	15:22369	NTIS (US Sales Only), PC A03/MF A01		DE90759895	
89-174	15:21736	NTIS (US Sales Only), PC A06/MF A01		DE90759925	
89-175	15:21719	NTIS (US Sales Only), PC A05/MF A01		DE90759896	
89-176	15:22222	NTIS (US Sales Only), PC A06/MF A01		DE90759926	
89-177	15:21159	NTIS (US Sales Only), PC A03/MF A01		DE90759927	
89-178	15:21730	NTIS (US Sales Only), PC A03/MF A01		DE90759902	
89-180	15:21443	NTIS (US Sales Only), PC A03/MF A01		DE90759897	
89-181	15:21493	NTIS (US Sales Only), PC A04/MF A01		DE90759929	
89-183	15:21737	NTIS (US Sales Only), PC A03/MF A01		DE90759901	
89-184	15:21803	NTIS (US Sales Only), PC A08/MF A01		DE90759928	
89-189	15:22546	NTIS (US Sales Only), PC A03/MF A01		DE90759904	
89-191	15:22256	NTIS (US Sales Only), PC A03/MF A01		DE90759898	
90-006	15:22940	Japan Atomic Energy Research Institute, Dept. of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
90-012	15:22925	Japan Atomic Energy Research Inst., Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JET-R–					
89-12	15:23052	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618740	
89-13	15:23053	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618599	
89-14	15:23131	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618841	
89-15	15:23054	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618741	
JPL-PUBL–					
89-28	15:22360	*See* N–90-14084			
89-47	15:21618	*See* N–90-14672			
Juel–					
2296	15:22885	Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek			
Juel-Conf–					
77	15:22147	NTIS (US Sales Only), PC A23/MF A01		DE90759592	
Juel-Spez–					
503	15:22769	NTIS (US Sales Only), PC A24/MF A01; OSIT; INIS		DE90759497	
K/CSD/TM–					
90	15:22978	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008005	MF-505
K/ITP–					
270	15:21450	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008463	MF-517
K/QT–					
352	15:21133	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008737	MF-109
KAPL–					
4713	15:22116	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008130	PC-500; PC-504
KEK–					
89-13	15:22947	NTIS (US Sales Only), PC A07/MF A01		DE90760025	
89-14	15:23055	NTIS (US Sales Only), PC A06/MF A01		DE90759999	
KFK–					
4668	15:22117	NTIS (US Sales Only), PC A09/MF A01		DE90759495	
KFK-PEF–					
54	15:22505	NTIS (US Sales Only), PC A06/MF A01; OSIT; INIS		DE90759333	
KO–					
019-90	15:22791	*See* EGG–10617-6066			
215-89	15:22790	*See* EGG–10617-6062			
KTA-GS–					
12(1989)	15:21687	NTIS (US Sales Only), PC A07/MF A01		DE90759361	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
L–					
16610	15:22941	*See* N–90-14890			
LA–					
11619-Vol.1	15:22233	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008129	PC-701
11619-Vol.2	15:22234	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008139	PC-701
11740-MS	15:22753	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006346	PC-907
11746-MS	15:22118	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008287	MF-704
11759-OBES	15:21633	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008035	MF-403
11772-MS	15:23215	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007696	MF-905
LA-UR–					
89-2722	15:23217	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016592	MF-905
89-4110	15:23132	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004841	MF-712
90-32	15:23218	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007887	MF-905
90-371	15:21495	NTIS, PC A03/MF A01; OSTI; INIS		DE90007548	MF-814
90-413	15:22324	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007622	
90-419	15:22754	NTIS, PC A03/MF A01 - OSTI		DE90007623	
90-432	15:22811	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007624	MF-700
90-485	15:22223	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007534	MF-701
90-564	15:21287	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007543	MF-122
90-590	15:22257	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007544	
90-613	15:23219	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007491	MF-800
90-650	15:22465	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007497	
90-692	15:23056	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007507	MF-910
90-698	15:21631	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007509	MF-251
90-701	15:21496	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007510	MF-940
LAL–					
88-11	15:22887	NTIS (US Sales Only), PC A03/MF A01		DE90756406	
88-12	15:22888	NTIS (US Sales Only), PC A03/MF A01		DE90756407	
88-13	15:22889	NTIS (US Sales Only), PC A03/MF A01		DE90756455	
88-47	15:22890	NTIS (US Sales Only), PC A03/MF A01		DE90756415	
88-52	15:23216	NTIS (US Sales Only), PC A03/MF A01		DE90756347	
88-55	15:22949	NTIS (US Sales Only), PC A03/MF A01		DE90756405	
88-61	15:22891	NTIS (US Sales Only), PC A03/MF A01		DE90756443	
LBH–					
89-05734	15:21583	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
LBL–					
24578	15:23252	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008067	MF-405
24872	15:21994	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007776	MF-350
24915	15:22793	NTIS, PC A07/MF A01; OSTI; INIS		DE90008065	MF-800
25429	15:21995	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007772	MF-350
26262	15:21996	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008046	PC-350
27032	15:21997	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008048	PC-350
27114	15:21943	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008045	PC-350
27277	15:21998	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007755	
27315	15:21999	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007763	MF-350
27338	15:21497	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008051	PC-802
27359	15:23253	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007775	MF-405
27394	15:22446	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008055	PC-414
27401	15:21498	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007769	MF-400
27460	15:22755	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008061	PC-408
27461	15:22972	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007767	MF-406
27473	15:21880	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008054	PC-404
27512	15:21944	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008073	MF-350
27522	15:22965	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007761	MF-406
27603	15:22359	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007780	MF-414
27676	15:22370	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008493	MF-414
27764	15:21945	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008057	PC-400
27805	15:21134	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008063	MF-109
27812	15:22420	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007765	MF-406
27840	15:22919	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008058	PC-413
27873	15:23254	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007069	MF-406
27905	15:22241	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008047	PC-404
27948	15:22725	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008072	MF-408; MF-405
27995	15:22000	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008071	MF-350

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
27996	15:22001	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008064	MF-350
28015	15:21499	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008053	PC-403
28029	15:22371	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008052	PC-411
28042	15:22756	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007560	
28057	15:21179	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008050	PC-101; PC-102; PC-108; PC-105
28101	15:23196	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007076	MF-400
28112	15:22892	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007757	MF-414
28114	15:22372	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007774	MF-414
28126	15:22855	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008388	MF-401
28164	15:21881	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008066	MF-213
28196	15:22893	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008495	MF-413
28206	15:22856	NTIS, PC A02/MF A01 - OSTI		DE90007779	MF-404
28207	15:22603	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008492	MF-402
28225	15:22716	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007760	MF-401
28249	15:22726	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008465	MF-408
28250	15:22727	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008466	MF-408
28251	15:22728	NTIS, PC A02/MF A01; OSTI; INIS		DE90007777	MF-408
28253	15:22729	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008467	MF-408
28254	15:22730	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007756	MF-408
28255	15:22731	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008496	MF-408
28263	15:22150	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007778	MF-404
28264	15:23133	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008068	PC-411
28266	15:21135	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008464	MF-109; MF-113
28271	15:22235	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008494	MF-401
28279	15:22794	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007758	MF-800
28294	15:22119	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007764	MF-404
28298	15:21136	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008389	MF-109
28316	15:21500	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007771	MF-814
28321	15:22002	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007770	MF-402; MF-350
28328	15:21501	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007766	MF-810
28333	15:21502	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007759	MF-810
28353	15:22224	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007762	MF-401
28358	15:21503	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007768	MF-814
28362	15:21504	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008387	MF-703; MF-721
28405	15:22120	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008390	MF-404
28407	15:21911	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008056	PC-400
28481	15:22447	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008074	MF-414; MF-406
91-Rev.-9/89	15:22880	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008062	PC-414
LBL-PUB–					
3078	15:22121	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007754	MF-404
LJI-R–					
81-146	15:22843	*See* AD-A–214656/1/XAB			
LPI-CONTRIB–					
712	15:22822	*See* N–90-14998			
LPNHEP–					
88-11	15:22894	NTIS (US Sales Only), PC A02/MF A01		DE90756362	
LRP–					
386/89	15:22325	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706060	
392/90	15:23058	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618601	
394/90	15:23059	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618602	
LYCEN–					
88-18	15:22902	NTIS (US Sales Only), PC A02/MF A01		DE90756361	
LYCEN-T–					
88-09	15:22966	NTIS (US Sales Only), PC A06/MF A01		DE90756360	
M–					
277	15:22466	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008258	MF-705
278	15:22467	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008256	MF-705
285	15:23220	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007858	MF-405
MAFF-AEMR–					
21	15:22604	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619475	

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MBL–					
1989-3	15:22757	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619498	
1989-5-A83/K/70	15:22758	Available from Library KNAW; P.O.Box 41950, 1009 DD Amsterdam, Netherlands			
MC/SC–					
AS/87/26	15:21418	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MH–					
18706011	15:21649	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MHETA–					
80-000-117	15:21155	*See* PB–90-130154/XAB			
MICROLOG–					
87-03768	15:21326	*See* SASKOIL–03768			
89-02586	15:22782	*See* OH/RD–88-56-K			
89-04486	15:21302	*See* CEG–C212.0002			
89-04487	15:21424	*See* STA/O–167-87-30			
89-04487	15:21425	*See* STA/O–190-89-30			
89-04629	15:21338	*See* TC/MCI–89-04629			
89-05124	15:21291	*See* NOIA–89-05124			
89-05197	15:21339	*See* TC/MCI–89-05197			
89-05344	15:21591	*See* RCA–BC-X-308			
89-05373	15:22084	*See* BCR–TE-87-10			
89-05389	15:22284	*See* OI–41-10986			
89-05406	15:22291	*See* OU/ME–89-06			
89-05472	15:22503	*See* GU/G–EN57-27/1989-01			
89-05613	15:21609	*See* ORF–ES/EDP-87-02			
89-05631	15:21579	*See* BCR–4-03-842			
89-05633	15:21590	*See* DU/IRES–89-05633			
89-05636	15:21649	*See* MH–18706011			
89-05643	15:21623	*See* BMDSI–89-05643			
89-05650	15:21608	*See* CSR–C225F			
89-05734	15:21583	*See* LBH–89-05734			
89-05736	15:21646	*See* INDAL–89-05736			
89-05741	15:21647	*See* INDAL–89-05741			
89-05742	15:21653	*See* TES–C937-14			
89-05743	15:21643	*See* ATPPB–89-05743			
89-05744	15:21648	*See* INDAL–89-05744			
89-05746	15:21584	*See* QU/CE–89-05746			
89-05772	15:21322	*See* ESL–8905772			
89-05889	15:21601	*See* ANA–89-15			
89-05944	15:22174	*See* EJF–89-05944			
89-05945	15:21600	*See* OU/CVE–89-05945			
89-05958	15:21645	*See* RV–T4-W10			
89-05994	15:21644	*See* AUI–34			
89-06066	15:22072	*See* CCREM–TS/WM-TREOO3			
89-06086	15:22088	*See* RFW–89-06086			
89-06087	15:22089	*See* RFW–89-06087			
89-06172	15:22589	*See* AI–89-06172			
89-06211	15:21417	*See* EMR/CR–89-06211			
89-06219	15:22283	*See* FTC–2312C-1			
89-06222	15:22039	*See* AI–P8072.00			
89-06232	15:22111	*See* GAI–89-06232			
89-06234	15:21594	*See* OU/C–89-06234			
89-06258	15:21904	*See* NBNRE/FM–89-06258			
89-06294	15:21961	*See* AMA–89-06294			
89-06301	15:21351	*See* RMCC/ME–AF-89-02			
89-06315	15:21871	*See* OH/RD–89-86-K			
89-06322	15:21665	*See* OH/RD–89-183-K			
89-06330	15:21598	*See* OH/RD–89-134-K			

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89-06352	15:21415	*See* EMR–89-06352			
89-06353	15:21416	*See* EMR–89-06353			
89-06355	15:21973	*See* GKYA–89-06355			
89-06380	15:21890	*See* OH/RD–706.01(#245)			
89-06380	15:21891	*See* OH/RD–706.01(#281)			
90-00179	15:21304	*See* WU/CE–90-00179			
90-00180	15:21418	*See* MC/SC–AS/87/26			
90-00181	15:21141	*See* TAU–CPL8363-6/5475			
90-00253	15:21585	*See* TFRI–MR216e			
90-00381	15:21587	*See* IRTA–90-00381			
90-00382	15:21599	*See* AIL–90-00382			
90-00383	15:21588	*See* NBU/FE–46054			
90-00384	15:22042	*See* CC/W–57097A			
90-00385	15:22073	*See* CC/W–KI23410AO			
90-00386	15:21142	*See* WU/CE–90-00386			
90-00387	15:21586	*See* WU/CE–90-00387			
90-00391	15:21329	*See* INA/NO–QS-8435-000-EF-A1			
90-00403	15:21663	*See* OH/RD–89-66-K			
90-00404	15:21913	*See* OH/RD–89-89-K			
90-00407	15:22028	*See* OH/RD–89-99-K			
90-00410	15:21659	*See* OH/RD–89-98-K			
90-00419	15:21869	*See* OH/RD–89-31-K			
90-00422	15:21865	*See* OH/RD–89-216-K			
90-00444	15:21328	*See* IAND–QS-8439-000-EF-A1			
90-00574	15:21352	*See* BCMEMPR–90-00574			
90-00631	15:21853	*See* BCH–90-00631			
90-00638	15:21854	*See* BCH–90-0638			
90-00639	15:21855	*See* BCH–SP8905			
90-00642	15:21592	*See* EC–90-00642			
90-00664	15:21903	*See* ERCB–89-40			
90-00677	15:21912	*See* NBNRE/FM–90-00677			
90-00725	15:22049	*See* OME–90-00725			
90-00770	15:22034	*See* OT/TTE–AF-89-01			
90-00837	15:21203	*See* OMNR–90-00837			
90-00882	15:21905	*See* NS/EM–88-3			
90-00883	15:21902	*See* EMR–M1-5/1987			
90-00944	15:21888	*See* EMR/EMAS–90-00944			
90-01030	15:22605	*See* OME/WRB–88/3			
90-01033	15:21331	*See* WES–291-PL			
90-01034	15:21931	*See* CERI–32			
90-01035	15:21313	*See* CERI–31			
90-01054	15:21924	*See* EMR/EMAS–90-01054			
90-01077	15:21593	*See* OE/ARB–90-01077			
90-01110	15:22507	*See* MO/G–57-27/1988-08			
90-01129	15:22780	*See* AECB/ACNS–INF00299(E)			
90-01164	15:21974	*See* HME–90-01164			
90-01168	15:21874	*See* OH/RD–89-159-k			
90-01169	15:21662	*See* OH/RD–89-42-K			
90-01170	15:21664	*See* OH/RD–89-117-K			
90-01171	15:21668	*See* OH/RD–89-138-K			
90-01172	15:21667	*See* OH/RD–89-65-K			
90-01175	15:21873	*See* OH/RD–89-152-K			
90-01177	15:21870	*See* OH/RD–89-79-K			
90-01181	15:22294	*See* CSR–90-01181			
90-01183	15:21327	*See* EMR–104			
MISC–					
89060	15:21791	*See* DOE/ID–10238			
MITNE–					
281	15:21505	NTIS, PC A12/MF A01; OSTI; INIS		DE90007744	MF-510
MLM–					
3628-OP	15:22469	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007637	MF-742
MML–					
1989-1	15:22164	*See* AD-A–214843/5/XAB			
MO/G–					
57-27/1988-08	15:22507	PC National Climatological Information Services, CCAS/I, 4905 Dufferin Street, Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			

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MPE-PREPRINT–					
156	15:22815	*See* N–90-14156			
MRC/WDC-R–					
166	15:23230	*See* UCRL–21276			
MRL-TR–					
89-3	15:22482	*See* AD-A–215037/3/XAB			
N–					
90-13297	15:22812	NTIS, PC A03/MF A01			
90-13387	15:22272	NTIS, PC A03/MF A01			
90-13589	15:22242	NTIS, PC A09/MF A02			
90-13590	15:22258	NTIS, PC A03/MF A01			
90-13596	15:21857	NTIS, PC A03/MF A01			
90-13609	15:22180	NTIS, PC A03/MF A01			
90-13618	15:22508	NTIS, PC A03/MF A01			
90-13636	15:22151	NTIS, PC A02/MF A01			
90-13666	15:22152	NTIS, PC A04/MF A01			
90-13718	15:21957	NTIS, PC A03/MF A01			
90-13747	15:22243	NTIS, PC A03/MF A01			
90-13761	15:22463	NTIS, PC A02/MF A01			
90-13819	15:22122	NTIS, PC A03/MF A01			
90-13880	15:21162	NTIS, PC A13/MF A02			
90-13886	15:21617	NTIS, PC A03/MF A01			
90-14076	15:22813	NTIS, PC A03/MF A01			
90-14084	15:22360	NTIS, PC A02/MF A01			
90-14102	15:23060	NTIS, PC A03/MF A01			
90-14108	15:22181	NTIS, PC A03/MF A01			
90-14154	15:22814	NTIS, PC A05/MF A01			
90-14156	15:22815	NTIS, PC A03/MF A01			
90-14160	15:22816	NTIS, PC A02/MF A01			
90-14163	15:22817	NTIS, PC A02/MF A01			
90-14167	15:22818	NTIS, PC A03/MF A01			
90-14168	15:22819	NTIS, PC A03/MF A01			
90-14176	15:22820	NTIS, PC A02/MF A01			
90-14178	15:22821	NTIS, PC A03/MF A01			
90-14281	15:21624	NTIS, PC A03/MF A01			
90-14284	15:21574	NTIS, PC A03/MF A01			
90-14287	15:22182	NTIS, PC A03/MF A01			
90-14305	15:22244	NTIS, PC A02/MF A01			
90-14362	15:22153	NTIS, PC A03/MF A01			
90-14368	15:22154	NTIS, PC A03/MF A01			
90-14641	15:22123	NTIS, PC A03/MF A01			
90-14642	15:22124	NTIS, PC A03/MF A01			
90-14672	15:21618	NTIS, PC A03/MF A01			
90-14844	15:22273	NTIS, PC A03/MF A01			
90-14874	15:22225	NTIS, PC A03/MF A01			
90-14890	15:22941	NTIS, PC A03/MF A01			
90-14910	15:23061	NTIS, PC A03/MF A01			
90-14934	15:23062	NTIS, PC A02/MF A01			
90-14998	15:22822	NTIS, PC A15/MF A02			
90-15004	15:22823	NTIS, PC A03/MF A01			
90-15030	15:21712	NTIS, PC A03/MF A01			
90-15036	15:22824	NTIS, PC A03/MF A01			
NAS–					
1.15:100372	15:22824	*See* N–90-15036			
1.15:100753	15:22180	*See* N–90-13609			
1.15:101311	15:22122	*See* N–90-13819			
1.15:101929	15:22225	*See* N–90-14874			
1.15:101974	15:21857	*See* N–90-13596			
1.15:102090	15:21712	*See* N–90-15030			
1.15:102313	15:22258	*See* N–90-13590			
1.15:102348	15:22123	*See* N–90-14641			
1.15:102351	15:22152	*See* N–90-13666			
1.15:102360	15:22182	*See* N–90-14287			
1.15:102384	15:22273	*See* N–90-14844			
1.15:102408	15:22151	*See* N–90-13636			
1.15:102411	15:22153	*See* N–90-14362			
1.15:102423	15:22154	*See* N–90-14368			
1.15:102459	15:21574	*See* N–90-14284			
1.15:4133	15:22124	*See* N–90-14642			
1.15:4141	15:22272	*See* N–90-13387			
1.26:182249	15:22242	*See* N–90-13589			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
1.26:182961	15:22816	*See* N–90-14160			
1.26:184598	15:23060	*See* N–90-14102			
1.26:185134	15:21624	*See* N–90-14281			
1.26:185153	15:22463	*See* N–90-13761			
1.26:185162	15:22181	*See* N–90-14108			
1.26:185321	15:21162	*See* N–90-13880			
1.26:185375	15:22814	*See* N–90-14154			
1.26:185923	15:22813	*See* N–90-14076			
1.26:185949	15:22823	*See* N–90-15004			
1.26:185960	15:22817	*See* N–90-14163			
1.26:185961	15:22820	*See* N–90-14176			
1.26:185963	15:21957	*See* N–90-13718			
1.26:185996	15:21617	*See* N–90-13886			
1.26:186000	15:22508	*See* N–90-13618			
1.26:186004	15:22815	*See* N–90-14156			
1.26:186076	15:22812	*See* N–90-13297			
1.26:186102	15:22243	*See* N–90-13747			
1.26:186103	15:22821	*See* N–90-14178			
1.26:186107	15:22360	*See* N–90-14084			
1.26:186114	15:21618	*See* N–90-14672			
1.26:186127	15:23061	*See* N–90-14910			
1.26:186160	15:22822	*See* N–90-14998			
1.26:186162	15:22244	*See* N–90-14305			
1.26:186166	15:22818	*See* N–90-14167			
1.26:186169	15:22819	*See* N–90-14168			
1.26:186238	15:23062	*See* N–90-14934			
1.60:2968	15:22941	*See* N–90-14890			
NASA-CR–					
182249	15:22242	*See* N–90-13589			
182961	15:22816	*See* N–90-14160			
184598	15:23060	*See* N–90-14102			
185134	15:21624	*See* N–90-14281			
185153	15:22463	*See* N–90-13761			
185162	15:22181	*See* N–90-14108			
185174	15:22080	*See* DOE/NASA–0282-1			
185321	15:21162	*See* N–90-13880			
185375	15:22814	*See* N–90-14154			
185923	15:22813	*See* N–90-14076			
185949	15:22823	*See* N–90-15004			
185960	15:22817	*See* N–90-14163			
185961	15:22820	*See* N–90-14176			
185963	15:21957	*See* N–90-13718			
185996	15:21617	*See* N–90-13886			
186000	15:22508	*See* N–90-13618			
186004	15:22815	*See* N–90-14156			
186076	15:22812	*See* N–90-13297			
186102	15:22243	*See* N–90-13747			
186103	15:22821	*See* N–90-14178			
186107	15:22360	*See* N–90-14084			
186114	15:21618	*See* N–90-14672			
186127	15:23061	*See* N–90-14910			
186160	15:22822	*See* N–90-14998			
186162	15:22244	*See* N–90-14305			
186166	15:22818	*See* N–90-14167			
186169	15:22819	*See* N–90-14168			
186238	15:23062	*See* N–90-14934			
NASA-TM–					
100372	15:22824	*See* N–90-15036			
100753	15:22180	*See* N–90-13609			
101311	15:22122	*See* N–90-13819			
101929	15:22225	*See* N–90-14874			
101974	15:21857	*See* N–90-13596			
102090	15:21712	*See* N–90-15030			
102313	15:22258	*See* N–90-13590			
102348	15:22123	*See* N–90-14641			
102351	15:22152	*See* N–90-13666			
102360	15:22182	*See* N–90-14287			
102384	15:22273	*See* N–90-14844			
102408	15:22151	*See* N–90-13636			
102411	15:22153	*See* N–90-14362			
102423	15:22154	*See* N–90-14368			

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102459	15:21574	*See* N–90-14284			
102476	15:22033	*See* DOE/NASA/50162–3			
4133	15:22124	*See* N–90-14642			
4141	15:22272	*See* N–90-13387			
NASA-TP–					
2968	15:22941	*See* N–90-14890			
NBNRE/FM–					
89-06258	15:21904	PC New Brunswick Dept. of Forest, Mines and Energy, Centennial Bldg., PO Box 6000, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
90-00677	15:21912	PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NBU/FE–					
46054	15:21588	PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NCEL-TN–					
1798	15:22587	*See* AD-A–214557/1/XAB			
NCT–					
3789/607	15:22096	*See* AD-A–214061/4/XAB			
ND-R–					
1406(S)	15:22183	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90619435	
NDP–					
019/R1	15:22509	*See* ORNL/CDIAC–30			
NEANDC(J)–					
141/U	15:22918	*See* JAERI-M–89-129			
146/U	15:22940	*See* JAERI-M–90-006			
147/U	15:22925	*See* JAERI-M–90-012			
NEB–					
SS-22-1/1989-14E	15:21366	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
NEB-SS–					
22-1/1989-11E	15:21927	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
22-1/1989-11F	15:21928	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
22-1/1989-12E	15:21929	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
22-1/1989-12F	15:21930	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
22-1/1989-13	15:21336	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
NIIEFA-P-G–					
0773	15:22326	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619019	
NIKHEF-H–					
89-17	15:22911	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618365	
NIKHEF-K-AmPS–					
89-03	15:22395	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706052	
NIPER–					
388	15:21288	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000227	PC-122
428	15:21305	*See* AD-A–214497/0/XAB			
461	15:21289	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000225	PC-122
NIST/TN–					
1327	15:22464	*See* PB–90-130907/XAB			

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NISTIR–					
89/4028	15:22527	*See* PB–90-132705/XAB			
89/4135	15:23221	*See* PB–90-130253/XAB			
89/4147	15:22287	*See* PB–90-132739/XAB			
89/4170	15:22286	*See* PB–90-130295/XAB			
89/4183	15:21571	*See* PB–90-130279/XAB			
89/4184	15:22857	*See* PB–90-133158/XAB			
NMRDI–					
2-75-5231	15:21290	NTIS, PC A04/MF A01; OSTI; New Mexico Research and Development Institute Suite M, 457 Washington, S.E., Albuquerque, NM 87108		DE90007781	
2-77-5609	15:21619	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007783	MF-700
NOIA–					
89-05124	15:21291	PC Newfoundland Ocean Industries Assn., P.O. Box 487, St. John's, NF, CAN A1C 5K4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NOSC/TR–					
1321	15:22588	*See* AD-A–215040/7/XAB			
NS/EM–					
88-3	15:21905	PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NSS/G–					
112	15:21506	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620403	
NSS/R–					
130	15:21507	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620404	
133	15:21508	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90620405	
141	15:21509	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620406	
158	15:21510	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620407	
160	15:22548	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619464	
NUKEM-FuE–					
88040	15:21455	NTIS (US Sales Only), PC A03/MF A01		DE90759105	
88043	15:21731	NTIS (US Sales Only), PC A03/MF A01		DE90759104	
NUREG–					
0090-Vol.12-No.3	15:21804	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007273	
0750-Vol.30-Index-1	15:21713	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007224	
0797-Suppl.23	15:21805	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90007453	
1214-Rev.5	15:21714	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90007787	
1381	15:21806	NTIS, PC A16/MF A01; OSTI; INIS		TI90007210	
1392	15:22549	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007808	
NUREG/CR–					
2000-Vol.9-No.1	15:21715	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90008443	
4554-Vol.6	15:21458	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90007784	
4659-Vol.3	15:21837	NTIS, PC A04/MF A01 - GPO - OSTI		TI90007785	
4661	15:21838	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90007636	
4667-Vol.7	15:21839	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90008482	
4674-Vol.10	15:21840	NTIS, PC A20/MF A01 - GPO; OSTI; INIS		TI90007409	
5229-Vol.2	15:21841	NTIS, PC A03/MF A01; OSTI; INIS		TI90007690	
5256	15:21511	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90008483	
5273-Vol.4	15:21842	NTIS, PC A99/MF A01 - GPO; OSTI; INIS		TI90008333	
5286	15:21843	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007264	
5302	15:21844	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007220	
5316	15:21845	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90007218	
5376	15:21846	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90007219	
5405	15:21847	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90007222	
5435	15:21512	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90008391	
5450	15:21700	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90007786	
5476	15:21848	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90007706	

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5479	15:21849	NTIS, PC A03/MF A01 - GPO - OSTI		TI90008780	
NVO–					
334-1	15:21513	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90004833	PC-814
NVS–					
10	15:22759	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706053	
NWC-TP–					
6988	15:21629	*See* AD-A–214978/9/XAB			
OCPA–					
19M-4001	15:21897	*See* PB–90-132192/XAB			
ODMWG/P–					
(89)1	15:22496	*See* CEGB-RD-L–3481/P89			
OE/ARB–					
90-01077	15:21593	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OH/RD–					
706.01(#245)	15:21890	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
706.01(#281)	15:21891	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
88-56-K	15:22782	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-117-K	15:21664	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-134-K	15:21598	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-138-K	15:21668	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-152-K	15:21873	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-159-k	15:21874	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-183-K	15:21665	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-216-K	15:21865	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-31-K	15:21869	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-42-K	15:21662	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-65-K	15:21667	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-66-K	15:21663	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-79-K	15:21870	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-86-K	15:21871	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-89-K	15:21913	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-98-K	15:21659	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-99-K	15:22028	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
OI–					
41-10986	15:22284	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OME–					
90-00725	15:22049	PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OME/WRB–					
88/3	15:22605	PC Ontario Business Development Division, Hearst Block, 900 Bay St., Toronto, ON, CAN M7A 2E1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OMNR–					
90-00837	15:21203	PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ORF–					
ES/EDP-87-02	15:21609	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ORNL–					
6590	15:22760	NTIS, PC A05/MF A01; OSTI; INIS: GPO Dep.	E 1.99:	DE90008018	
6608	15:22550	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008024	MF-630
6608/R1	15:22551	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008019	MF-630
ORNL/ATD–					
20	15:22285	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008022	MF-423
28/V2	15:23134	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008020	MF-422
ORNL/CDIAC–					
30	15:22509	NTIS, PC E17/MF E08 - OSTI; GPO Dep.	E 1.99:	DE90008029	MF-402
ORNL/CON–					
298	15:21946	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008078	MF-350
ORNL/FEDC–					
89/3	15:23063	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008087	PC-423; PC-424
89/4	15:23135	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008086	PC-423; PC-424
90/2	15:23136	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008088	PC-423; PC-424
ORNL/FMP–					
89/2	15:22094	NTIS, PC A25/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008393	MF-114
ORNL/FTR–					
3535	15:21514	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007487	MF-402; MF-403
3536	15:21947	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007572	MF-270
3539	15:22259	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007454	MF-402
3540	15:21688	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008371	MF-520
3541	15:23137	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008764	MF-420
3542	15:23138	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007642	MF-424
ORNL/M–					
1029	15:22552	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008763	MF-602
1030	15:22606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008080	MF-402
1045	15:21515	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008257	MF-602
1069	15:22029	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008036	MF-350
1081	15:21137	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007451	MF-114

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ORNL/M–					
1086	15:22607	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008392	MF-401
898	15:21781	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007608	MF-400
917	15:21465	*See* DOE/HWP–89			
ORNL/NOAC–					
232-Vol.10	15:21840	*See* NUREG/CR–4674-Vol.10			
ORNL/NSIC–					
200-Vol.9-No.1	15:21715	*See* NUREG/CR–2000-Vol.9-No.1			
ORNL/OMIS–					
90/1	15:22485	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008131	
ORNL/RASA–					
89/21	15:21543	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007704	MF-511
89/22	15:21544	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007703	MF-511
89/23	15:21545	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007702	MF-511
89/24	15:21516	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007701	MF-511
89/25	15:21517	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007700	MF-511
89/26	15:21546	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007699	MF-511
ORNL/TM–					
11010	15:22608	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008079	MF-402
11227	15:21518	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008076	MF-721
11295	15:21669	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008084	MF-950
11297/R1	15:22920	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008023	MF-413
11331	15:22050	NTIS, PC A03/MF A01; OSTI; Order Software Packages from National Energy Software Center, Argonne National Laboratory, 9800 South Cass Avenue, Argonne, IL 60439. Order documentation without complete package from NTIS.; GPO Dep.	E 1.99:	DE90008089	PC-350
11352	15:21700	*See* NUREG/CR–5450			
11386	15:21117	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008021	MF-102
11398	15:21849	*See* NUREG/CR–5479			
11420	15:23139	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008077	PC-421
11421	15:22783	NTIS, PC A25/MF A01 - OSTI		DE90008070	MF-600
11468	15:22979	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008082	MF-413
OT/TTE–					
AF-89-01	15:22034	PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OTA-BP-CIT–					
59	15:23222	*See* PB–90-131228/XAB			
OTA-O–					
412	15:22512	*See* PB–90-130451/XAB			
OU/C–					
89-06234	15:21594	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OU/CVE–					
89-05945	15:21600	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OU/ME–					
89-06	15:22291	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
PARAMETER/IE–					
158	15:21838	*See* NUREG/CR–4661			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
177	15:21843	*See* NUREG/CR–5286			
193	15:21844	*See* NUREG/CR–5302			
PATENTS-USA–					
Application7-414,223	15:22135	NTISPC N03/MF A01			
Application7-373,555	15:22355	NTISPC N03/MF A01			
Application7-370,965	15:22356	NTISPC N03/MF A01			
Application7-432,993	15:22720	NTISPC N03/MF A01			
PB–					
90-117045/XAB	15:22609	NTIS, PC A04/MF A01			
90-121682/XAB	15:22155	NTIS, PC A06/MF A01			
90-128836/XAB	15:21577	NTIS, PC A03/MF A01			
90-129651/XAB	15:22610	NTIS, PC A04/MF A01			
90-129669/XAB	15:21906	NTIS, PC A03/MF A01			
90-130089/XAB	15:23064	NTIS, PC A03/MF A01			
90-130105/XAB	15:22510	NTIS, PC A04/MF A01			
90-130113/XAB	15:22611	NTIS, PC A03/MF A01			
90-130121/XAB	15:22612	NTIS, PC A05/MF A01			
90-130139/XAB	15:22733	NTIS, PC A03/MF A01			
90-130154/XAB	15:21155	NTIS, PC A03/MF A01			
90-130253/XAB	15:23221	NTIS, PC A03/MF A01			
90-130279/XAB	15:21571	NTIS, PC A09/MF A01			
90-130295/XAB	15:22286	NTIS, PC A05/MF A01			
90-130352/XAB	15:22511	NTIS, PC A08/MF A01			
90-130444/XAB	15:21894	NTIS, PC A11/MF A02			
90-130451/XAB	15:22512	NTIS, PC A11/MF A02			
90-130493/XAB	15:22051	NTIS, PC A07/MF A01			
90-130527/XAB	15:22772	NTIS, PC A04/MF A01			
90-130626/XAB	15:22761	NTIS, PC A03/MF A01			
90-130659/XAB	15:21180	NTIS, PC A03/MF A01			
90-130709/XAB	15:22613	NTIS, PC A04/MF A01			
90-130816/XAB	15:21372	NTIS, PC A03/MF A01			
90-130832/XAB	15:22513	NTIS, PC A19/MF A03			
90-130873/XAB	15:21367	NTIS, PC A02/MF A01			
90-130907/XAB	15:22464	NTIS, PC A03/MF A01			
90-131020/XAB	15:21181	NTIS, PC A03/MF A01			
90-131046/XAB	15:21895	NTIS, PC A03/MF A01			
90-131053/XAB	15:21896	NTIS, PC A03/MF A01			
90-131228/XAB	15:23222	NTIS, PC A04/MF A01			
90-131244/XAB	15:21368	NTIS, PC A02/MF A01			
90-131251/XAB	15:21375	NTIS, PC A03/MF A01			
90-131269/XAB	15:21373	NTIS, PC A03/MF A01			
90-131293/XAB	15:21958	NTIS, PC A05/MF A01			
90-131301/XAB	15:22074	NTIS, PC A10/MF A02			
90-131335/XAB	15:22514	NTIS, PC A03/MF A01			
90-131343/XAB	15:22515	NTIS, PC A03/MF A01			
90-131350/XAB	15:22516	NTIS, PC A03/MF A01			
90-131376/XAB	15:22517	NTIS, PC A03/MF A01			
90-131434/XAB	15:22518	NTIS, PC A05/MF A01			
90-131442/XAB	15:22519	NTIS, PC A06/MF A01			
90-131459/XAB	15:22520	NTIS, PC A99/MF A04			
90-131483/XAB	15:22614	NTIS, PC A05/MF A01			
90-131491/XAB	15:22521	NTIS, PC A03/MF A01			
90-131509/XAB	15:22522	NTIS, PC A03/MF A01			
90-131533/XAB	15:22075	NTIS, PC A06/MF A01			
90-131541/XAB	15:21138	NTIS, PC A05/MF A01			
90-131582/XAB	15:22773	NTIS, PC A05/MF A01			
90-131616/XAB	15:21578	NTIS, PC A02/MF A01			
90-131624/XAB	15:22732	NTIS, PC A03/MF A01			
90-131657/XAB	15:22553	NTIS, PC A03/MF A01			
90-131665/XAB	15:21139	NTIS, PC EE03/MF E03			
90-131863/XAB	15:22523	NTIS, PC A03/MF A01			
90-131889/XAB	15:22717	NTIS, PC A02/MF A01			
90-131996/XAB	15:21374	NTIS, PC A03/MF A01			
90-132002/XAB	15:21355	NTIS, PC A04/MF A01			
90-132010/XAB	15:21596	NTIS, PC A04/MF A01			
90-132028/XAB	15:21597	NTIS, PC A04/MF A01			
90-132192/XAB	15:21897	NTIS, PC EE09/MF A04			
90-132341/XAB	15:22524	NTIS, PC A09/MF A02			
90-132515/XAB	15:21369	NTIS, PC A02/MF A01			
90-132523/XAB	15:21362	NTIS, PC A06/MF A01			
90-132648/XAB	15:22615	NTIS, PC A07/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-132663/XAB	15:22525	NTIS, PC A12/MF A02			
90-132689/XAB	15:22526	NTIS, PC A02/MF A01			
90-132705/XAB	15:22527	NTIS, PC A03/MF A01			
90-132739/XAB	15:22287	NTIS, PC A05/MF A01			
90-132812/XAB	15:22052	NTIS, PC A03/MF A01			
90-132903/XAB	15:22528	NTIS, PC A03/MF A01			
90-133125/XAB	15:22734	NTIS, PC A03/MF A01			
90-133158/XAB	15:22857	NTIS, PC A16/MF A02			
90-133372/XAB	15:21898	NTIS, PC A05/MF A01			
90-134529/XAB	15:21899	NTISMF A01			
90-134537/XAB	15:21907	NTISMF A02			
90-134578/XAB	15:21170	NTISMF A01			
90-135450/XAB	15:21156	NTIS, PC A06/MF A01			
90-135559/XAB	15:22616	NTIS, PC A01/MF A01			
90-136201/XAB	15:22617	NTIS, PC A02/MF A01			
90-137001/XAB	15:22618	NTIS, PC A03/MF A01			
90-137118/XAB	15:22619	NTIS, PC A03/MF A01			
90-137134/XAB	15:22620	NTIS, PC A03/MF A01			
90-137142/XAB	15:22554	NTIS, PC A03/MF A01			
90-137159/XAB	15:22621	NTIS, PC A03/MF A01			
90-137167/XAB	15:22622	NTIS, PC A03/MF A01			
90-137175/XAB	15:22623	NTIS, PC A02/MF A01			
90-137183/XAB	15:22624	NTIS, PC A03/MF A01			
90-137191/XAB	15:22625	NTIS, PC A02/MF A01			
90-137209/XAB	15:22626	NTIS, PC A03/MF A01			
90-137225/XAB	15:22555	NTIS, PC A02/MF A01			
90-137233/XAB	15:22627	NTIS, PC A02/MF A01			
90-137241/XAB	15:22628	NTIS, PC A02/MF A01			
90-137258/XAB	15:22629	NTIS, PC A03/MF A01			
90-137266/XAB	15:22630	NTIS, PC A03/MF A01			
90-137274/XAB	15:22631	NTIS, PC A03/MF A01			
90-137282/XAB	15:22632	NTIS, PC A02/MF A01			
90-137290/XAB	15:22633	NTIS, PC A02/MF A01			
90-137357/XAB	15:22634	NTIS, PC A02/MF A01			
90-137365/XAB	15:21900	NTIS, PC A03/MF A01			
90-137373/XAB	15:22635	NTIS, PC A03/MF A01			
90-137399/XAB	15:22636	NTIS, PC A02/MF A01			
90-137407/XAB	15:22556	NTIS, PC A02/MF A01			
90-137415/XAB	15:22637	NTIS, PC A03/MF A01			
90-137423/XAB	15:22638	NTIS, PC A03/MF A01			
90-137449/XAB	15:22639	NTIS, PC A03/MF A01			
90-137456/XAB	15:22640	NTIS, PC A02/MF A01			
90-137464/XAB	15:22641	NTIS, PC A02/MF A01			
90-137480/XAB	15:22642	NTIS, PC A02/MF A01			
90-137498/XAB	15:22643	NTIS, PC A03/MF A01			
90-137506/XAB	15:22557	NTIS, PC A02/MF A01			
90-137514/XAB	15:22644	NTIS, PC A03/MF A01			
90-137522/XAB	15:22645	NTIS, PC A02/MF A01			
90-137530/XAB	15:22646	NTIS, PC A02/MF A01			
90-137548/XAB	15:22647	NTIS, PC A02/MF A01			
90-137563/XAB	15:22558	NTIS, PC A02/MF A01			
90-137571/XAB	15:22648	NTIS, PC A02/MF A01			
90-137589/XAB	15:22559	NTIS, PC A03/MF A01			
90-137597/XAB	15:22649	NTIS, PC A03/MF A01			
90-137605/XAB	15:22650	NTIS, PC A03/MF A01			
90-137613/XAB	15:22651	NTIS, PC A03/MF A01			
90-137621/XAB	15:22652	NTIS, PC A03/MF A01			
90-137639/XAB	15:22653	NTIS, PC A02/MF A01			
90-137647/XAB	15:22560	NTIS, PC A02/MF A01			
90-137654/XAB	15:22654	NTIS, PC A03/MF A01			
90-137662/XAB	15:22655	NTIS, PC A02/MF A01			
90-137688/XAB	15:22561	NTIS, PC A03/MF A01			
90-137696/XAB	15:22562	NTIS, PC A03/MF A01			
90-137712/XAB	15:22656	NTIS, PC A03/MF A01			
90-137720/XAB	15:22563	NTIS, PC A02/MF A01			
90-137738/XAB	15:21519	NTIS, PC A02/MF A01			
90-137746/XAB	15:22564	NTIS, PC A02/MF A01			
90-137761/XAB	15:22565	NTIS, PC A03/MF A01			
90-137787/XAB	15:22657	NTIS, PC A02/MF A01			
90-138751/XAB	15:22658	NTIS, PC A02/MF A01			
90-138769/XAB	15:22659	NTIS, PC A03/MF A01			

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90-138777/XAB	15:22566	NTIS, PC A03/MF A01			
90-138785/XAB	15:22567	NTIS, PC A03/MF A01			
90-138793/XAB	15:22660	NTIS, PC A03/MF A01			
90-138801/XAB	15:22661	NTIS, PC A02/MF A01			
90-138819/XAB	15:22662	NTIS, PC A03/MF A01			
90-138827/XAB	15:22663	NTIS, PC A03/MF A01			
90-138835/XAB	15:22664	NTIS, PC A03/MF A01			
90-138843/XAB	15:22665	NTIS, PC A03/MF A01			
90-138850/XAB	15:22666	NTIS, PC A02/MF A01			
90-138868/XAB	15:22667	NTIS, PC A03/MF A01			
90-138876/XAB	15:22668	NTIS, PC A03/MF A01			
90-138884/XAB	15:22669	NTIS, PC A03/MF A01			
90-138926/XAB	15:22670	NTIS, PC A03/MF A01			
90-138934/XAB	15:22671	NTIS, PC A03/MF A01			
90-138942/XAB	15:22672	NTIS, PC A03/MF A01			
90-138959/XAB	15:22568	NTIS, PC A02/MF A01			
90-138967/XAB	15:22673	NTIS, PC A03/MF A01			
90-138983/XAB	15:22674	NTIS, PC A03/MF A01			
90-139007/XAB	15:22675	NTIS, PC A03/MF A01			
90-139015/XAB	15:22569	NTIS, PC A03/MF A01			
90-139023/XAB	15:22676	NTIS, PC A03/MF A01			
90-139031/XAB	15:22570	NTIS, PC A03/MF A01			
90-139049/XAB	15:22677	NTIS, PC A03/MF A01			
90-139072/XAB	15:22678	NTIS, PC A03/MF A01			
90-139080/XAB	15:22679	NTIS, PC A03/MF A01			
90-139106/XAB	15:22680	NTIS, PC A03/MF A01			
90-139114/XAB	15:22681	NTIS, PC A03/MF A01			
90-139122/XAB	15:22571	NTIS, PC A03/MF A01			
90-139130/XAB	15:22572	NTIS, PC A02/MF A01			
90-139155/XAB	15:22682	NTIS, PC A03/MF A01			
90-139163/XAB	15:22683	NTIS, PC A03/MF A01			
90-139171/XAB	15:22684	NTIS, PC A03/MF A01			
90-139197/XAB	15:22685	NTIS, PC A03/MF A01			
90-139213/XAB	15:22686	NTIS, PC A03/MF A01			
90-139957/XAB	15:22687	NTIS, PC A02/MF A01			
90-139965/XAB	15:22529	NTIS, PC A03/MF A01			
90-139973/XAB	15:22573	NTIS, PC A03/MF A01			
90-139999/XAB	15:22574	NTIS, PC A02/MF A01			
90-140005/XAB	15:22688	NTIS, PC A02/MF A01			
90-140013/XAB	15:22689	NTIS, PC A03/MF A01			
90-140039/XAB	15:22690	NTIS, PC A03/MF A01			
90-140047/XAB	15:22691	NTIS, PC A03/MF A01			
90-140070/XAB	15:22692	NTIS, PC A02/MF A01			
90-140088/XAB	15:22693	NTIS, PC A03/MF A01			
90-140096/XAB	15:22694	NTIS, PC A03/MF A01			
90-140104/XAB	15:22695	NTIS, PC A03/MF A01			
90-140112/XAB	15:22696	NTIS, PC A03/MF A01			
90-140120/XAB	15:22697	NTIS, PC A03/MF A01			
90-140138/XAB	15:22698	NTIS, PC A03/MF A01			
90-140146/XAB	15:22699	NTIS, PC A02/MF A01			
90-140153/XAB	15:22700	NTIS, PC A03/MF A01			
90-140161/XAB	15:22701	NTIS, PC A03/MF A01			
90-140179/XAB	15:22702	NTIS, PC A03/MF A01			
90-140435/XAB	15:22703	NTIS, PC A03/MF A01			
90-140443/XAB	15:22575	NTIS, PC A03/MF A01			
90-140997/XAB	15:21363	NTIS, PC A04/MF A01			
90-500968/XAB	15:22530	NTISCP T03			
90-500976/XAB	15:22531	NTISCP T02			
90-500984/XAB	15:22532	NTISCP T02			
90-500992/XAB	15:22533	NTISCP T02			
90-501008/XAB	15:21666	NTISCP D02			
90-855222/XAB	15:21520	NTISPC N01/MF N01			
90-855230/XAB	15:22534	NTISPC N01/MF N01			
90-855305/XAB	15:22825	NTISPC N01/MF N01			
90-855669/XAB	15:22718	NTISPC N01/MF N01			
90-855701/XAB	15:21650	NTISPC N01/MF N01			
90-855719/XAB	15:21651	NTISPC N01/MF N01			
90-855727/XAB	15:21573	NTISPC N01/MF N01			
90-855750/XAB	15:21882	NTISPC N01/MF N01			
90-855768/XAB	15:22736	NTISPC N01/MF N01			
90-855834/XAB	15:22053	NTISPC N01/MF N01			

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90-855859/XAB	15:22704	NTISPC N01/MF N01			
90-855958/XAB	15:22576	NTISPC N01/MF N01			
90-855966/XAB	15:22054	NTISPC N01/MF N01			
90-855982/XAB	15:22774	NTISPC N01/MF N01			
90-856006/XAB	15:22055	NTISPC N01/MF N01			
90-856014/XAB	15:22056	NTISPC N01/MF N01			
90-856071/XAB	15:22775	NTISPC N01/MF N01			
90-856121/XAB	15:22874	NTISPC N01/MF N01			
90-856261/XAB	15:22057	NTISPC N01/MF N01			
90-856337/XAB	15:23223	NTISPC N01/MF N01			
90-856345/XAB	15:23224	NTISPC N01/MF N01			
90-856378/XAB	15:23225	NTISPC N01/MF N01			
90-856386/XAB	15:23226	NTISPC N01/MF N01			
90-856568/XAB	15:21883	NTISPC N01/MF N01			
90-856642/XAB	15:22083	NTISPC N01/MF N01			
90-856709/XAB	15:22327	NTISPC N01/MF N01			
90-856725/XAB	15:22328	NTISPC N01/MF N01			
90-856733/XAB	15:22705	NTISPC N01/MF N01			
90-856766/XAB	15:21330	NTISPC N01/MF N01			
90-856865/XAB	15:22535	NTISPC N01/MF N01			
90-856873/XAB	15:22058	NTISPC N01/MF N01			
90-856881/XAB	15:22059	NTISPC N01/MF N01			
90-856907/XAB	15:22060	NTISPC N01/MF N01			
90-856915/XAB	15:22061	NTISPC N01/MF N01			
90-856923/XAB	15:22288	NTISPC N01/MF N01			
90-856931/XAB	15:22289	NTISPC N01/MF N01			
90-857012/XAB	15:22536	NTISPC N01/MF N01			
90-857020/XAB	15:22537	NTISPC N01/MF N01			
90-857046/XAB	15:22206	NTISPC N01/MF N01			
PCCIM–					
CE02873	15:21389	PC Petroleum Society of CIM, c/o AMOCO Canada, Box 200, Calgary, AB, CAN T2P 0H8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $45.00 CAN; MF $10 CAN			
PFC/RR–					
89-16	15:22989	*See* DOE/ET/51013–276			
90-1	15:22990	*See* DOE/ET/51013–278			
90-2	15:22991	*See* DOE/ET/51013–279			
PH–					
78-02-794-43-V-2	15:22483	*See* AD-A–955741/4/XAB			
PNL–					
6450-28-HEDR	15:21521	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008369	MF-707
7102	15:21522	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007613	MF-602; MF-630
7116	15:22578	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008099	MF-402
7203	15:21885	NTIS, PC A18/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008090	MF-212
7257	15:22706	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007615	MF-602; MF-603
PNL-MA–					
580	15:22493	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007682	MF-402
PNL-SA–					
15704	15:23140	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008611	MF-420
16902	15:21959	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008615	MF-110
16984	15:23141	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008603	MF-423
16989	15:23142	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008620	MF-420
16990	15:23143	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008612	MF-423
16998	15:23144	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008602	MF-423
17162	15:22156	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008624	MF-404
17905	15:22538	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008140	MF-402
POEF-T–					
3508	15:21445	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007847	MF-517
PPPL–					
2655	15:23065	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008776	PC-421
2678	15:23145	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008003	PC-426
2680	15:23066	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008004	PC-426; PC-427

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PRM–					
CE02870	15:22296	PC Infopall, Pallister Resource Management, Bay 105, 4116 - 64th. Ave., S.E., Calgary, AB, CAN T2C 2B3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $108.00 CAN; MF $10 CAN			
PROG–					
8860710	15:21958	*See* PB–90-131293/XAB			
PSI–					
42	15:22274	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90620070	
53	15:22579	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619465	
54	15:22580	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619466	
55	15:21721	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620127	
56	15:21722	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620128	
QU/CE–					
89-05746	15:21584	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
R–					
89-917447-32	15:22080	*See* DOE/NASA–0282-1			
RAL–					
89-086	15:22841	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619481	
89-089	15:23067	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618742	
89-090	15:23068	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618732	
89-095	15:22449	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620312	
89-096	15:22912	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90618366	
89-098	15:22826	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90618845	
89-101	15:22361	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620091	
89-102	15:22827	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90618846	
89-104	15:22951	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619118	
89-106	15:22895	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619111	
89-107	15:22967	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90618499	
89-112	15:22396	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620114	
RCA–					
BC-X-308	15:21591	PC Petawawa National Forestry Institute, Distribution Centre, P.O. Box 2000, Chalk River, ON, CAN K0J 1J0; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
RCM–					
00889	15:22236	NTIS (US Sales Only), PC A03/MF A01		DE90759319	
RCNP-P–					
106	15:22921	NTIS (US Sales Only), PC A08/MF A01		DE90760000	
REM-FM–					
89-2	15:22452	*See* AD-A–214634/8/XAB			
REPT–					
1123	15:22609	*See* PB–90-117045/XAB			
90B00039	15:22180	*See* N–90-13609			

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RFP–					
4406	15:21523	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007293	MF-702; MF-707
RFP-ENV–					
88	15:22581	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006469	MF-702
RFW–					
89-06086	15:22088	PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
89-06087	15:22089	PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
RI/RD–					
89-179	15:22242	*See* N–90-13589			
RISO-M–					
2813	15:22126	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90619343	
RMCC/ME–					
AF-89-02	15:21351	PC Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
RRK–					
89-29	15:22913	NTIS (US Sales Only), PC A04/MF A01		DE90759876	
RV–					
T4-W10	15:21645	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
Rijnhuizen-report–					
89-186	15:23146	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90618809	
SAND–					
88-1465	15:21850	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007614	MF-610
88-3020	15:21511	*See* NUREG/CR–5256			
88-3476	15:21845	*See* NUREG/CR–5316			
89-0773	15:22184	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007782	MF-706
89-1482	15:23227	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008134	MF-905
89-1514C	15:22127	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007821	MF-706
89-1650	15:21847	*See* NUREG/CR–5405			
89-1747	15:22329	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008135	MF-706
89-1930C	15:22185	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005593	MF-704
89-2044C	15:22260	NTIS, PC A02/MF A01 - OSTI		DE90007216	MF-706
89-2070C	15:22330	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007287	MF-743
89-2106	15:22261	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008136	MF-706
89-2111C	15:22035	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007653	MF-743
89-2112C	15:22036	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007820	MF-743
89-2113C	15:22037	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007677	MF-743
89-2236C	15:21620	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007685	MF-700
89-2262C	15:22480	NTIS, PC A02/MF A01 - OSTI		DE90006185	MF-705; MF-706
89-2293C	15:22481	NTIS, PC A02/MF A01 - OSTI		DE90006183	MF-706
89-2297C	15:21205	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007071	MF-703
89-2399	15:21140	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007607	MF-108; MF-114
89-2414C	15:22262	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002585	MF-706
89-2494C	15:22263	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008311	MF-706

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89-2506C	15:22264	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007687	MF-705
89-2510C	15:22265	NTIS, PC A02/MF A01 - OSTI		DE90002101	MF-706
89-2511C	15:22266	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002238	MF-706; MF-721; MF-705
89-2522C	15:22267	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002313	MF-706
89-2527C	15:22268	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001678	MF-705
89-2603	15:21848	*See* NUREG/CR–5476			
89-2654	15:21915	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008027	PC-700
89-2670C	15:23228	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008739	MF-705
89-2696C	15:22186	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006020	MF-704; MF-706
89-2698	15:23199	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008133	MF-900
89-2700C	15:23200	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007286	MF-700; MF-705
89-2764C	15:22795	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003839	MF-703
89-3025C	15:22331	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005196	MF-706
89-3039	15:21884	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007996	MF-212
89-3040C	15:22875	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006537	MF-700; MF-706
89-7041	15:21621	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008040	MF-274
89-7096	15:22128	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008069	PC-722
90-0052C	15:23229	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008501	MF-705
90-0077C	15:22187	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006535	MF-704
90-0231C	15:22332	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006772	MF-706
90-0259C	15:22470	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007683	MF-706; MF-742
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03768	15:21326	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN			
SCIE-DOE–					
201-89	15:21448	*See* DOE/EH/79081–T1			
SERI/TP–					
257-3663	15:21652	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000317	MF-261
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211-3621	15:21627	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000310	MF-270
215-3513A	15:21611	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009447	MF-233; MF-234
234-3610	15:22188	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000300	MF-370
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89-1054-6657-16	15:21660	*See* DOE/PC/88867–T5			
SSS-DTR–					
89-10483	15:22474	*See* AD-A–214875/7/XAB			
STA/O–					
167-87-30	15:21424	Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1. Prices: PRICES UPON REQUEST			
190-89-30	15:21425	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

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58	15:22189	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90619432	
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C937-14	15:21653	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
TFRI–					
MR216e	15:21585	PC International Development Research Centre, 250 Albert Street, P.O. Box 8500, Ottawa, ON, CAN K1G 3H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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20622-89-2	15:22476	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008298	MF-701; MF-704

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20674-Vol.6	15:21458	*See* NUREG/CR–4554-Vol.6			
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21793	15:22981	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008060	MF-700
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89-17	15:22903	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007810	MF-414
89-18	15:22897	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007811	MF-414
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USGS-OFR–					
90-105	15:21528	NTIS, PC A03/MF A01; OSTI; U.S. Geological Survey, Open File Service, Denver Federal Center, Box 25425, Denver, CO 80225; GPO Dep.	E 1.99:	DE90008478	MF-703
USGS/OFR–					
87-558	15:22525	*See* PB–90-132663/XAB			
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84-0022	15:21530	NTIS, PC A06/MF A01; OSTI; INIS		DE90007621	MF-721
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291-PL	15:21331	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
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89-1298	15:21547	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007119	MF-702
89-981	15:21451	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008128	PC-704
WU/CE–					
90-00179	15:21304	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-00386	15:21142	PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-00387	15:21586	PC Efficiency and Alternative Energy Branch, Energy, Mines and Resources, 460 O'Connor St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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89-11	15:21535	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620392	
89-12	15:21851	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620393	
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The correlation list is provided for those organizations that file documents by report number but may receive requests by order number. For more information about a document, refer to the Report Number Index.

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